A VFT APPROACH TO ALLOCATION OF MANPOWER AND BUDGET CUTS

THESIS

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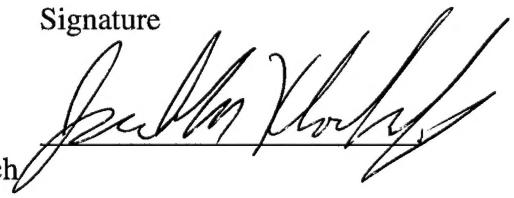
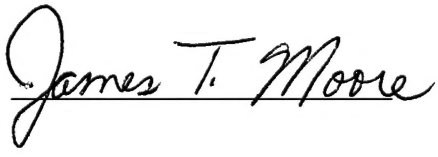
Advisor	Jack M. Kloeber, Jr., LTC, USA Assistant Professor of Operations Research Department of Operational Sciences Graduate School of Engineering	
Reader:	James T. Moore, Lt Col, USAF Associate Professor of Operations Research Department of Operational Sciences Graduate School of Engineering	

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Table of Contents

Page

Page

List of Figures

List of Tables

Abstract

The National Air Intelligence Center (NAIC), like many Department of Defense (DoD) and civilian organizations, has been forced to undergo budget and manpower reductions. This year's resource allocation decision requires NAIC to identify both contracts and personnel to be cut. In order to reduce the amount of time and subjectivity involved in this important decision, a resource allocation model was developed to compare different alternatives. This model uses decision analysis with value-focused thinking to quantify the resultant impact of the chosen cuts. The impact was quantified based upon the NAIC Commander's values and preferences, which were used to build a value hierarchy. Each of the 60 contracts, as well as the 5, 10, 15 and 20% manpower cuts for the 18 organizations within NAIC, were evaluated against 49 attributes, which represented the Commander's values. Using multi-attribute utility theory, the subjective scores were multiplied by the commander's preference to arrive at an overall utility score. In addition to identifying the absolute best alternative, a rank ordering based upon the impact/cost ratio was supplied to the NAIC Commander. By including sensitivity analysis on the commander's preferences, NAIC could better understand their resource allocation problem and make a more-informed decision.

A VFT APPROACH TO ALLOCATION OF MANPOWER AND BUDGET CUTS

I. Introduction

1.1 Background

Ever since the end of the Cold War, the Department of Defense (DoD) has been forced to reevaluate the way it provides for the defense of the nation. The United States Congress dictates how money is divided among various organizations. Although some organizations get fully funded, many organizations face annual cutbacks which cause an elimination or reduction of resources.

In order to deal with these reductions, organizations within each of the Services are regularly tasked to perform internal evaluations of their own resources. These evaluations typically coincide with a budget cut, and therefore help identify the best way to allocate the unit's resources. The National Air Intelligence Center (NAIC) has once again been mandated to reduce the resources it uses. NAIC has historically used a form of "Alternative Focused Thinking" to allocate their resources (7). The Commander has chosen an alternative, defined as a group of budget and manpower cuts, from a list of alternatives submitted by members of his Senior Management Team (SMT). This method embodied the SMT's subjective views and expert evaluations. It was inherently time consuming and considered by the SMT members themselves as highly unscientific.

This research applies decision analysis, which provides a structured method for looking at difficult decision problems, and is intended to resolve the problems involving resource reductions that have plagued NAIC over the years.

1.2 Problem Statement

NAIC must cut 49 positions and $8.716 million by FY05. Rather than allowing the Air Intelligence Agency to identify where the money and manpower should be cut, NAIC chose to tackle the challenge of resource allocation. NAIC must identify which organizations should lose how many positions and which contracts should be cut.

The important decision of what should be cut and from which organization has been made without having a method to quantify the impact of these cuts on NAIC's mission performance. In such a complex decision environment, without quantification it is very difficult to select the best alternative or to determine how good the selected alternative is.

1.3 Research Objective

There are both short and long-term goals for doing this research for NAIC. The short-term goal is to help the NAIC Commander make the best resource allocation decision by analyzing numerous cut-back alternatives and quantitatively evaluating their negative impact on NAIC. The evaluation method should be based on the areas that he believes impact NAIC's ability to perform its mission.

The long-term goal is to empower NAIC's plans and policy office with the ability to efficiently generate better alternatives for the Commander to review. Peripherally, by helping analyze this difficult decision, the Commander's values and preferences will be circulated throughout the organization, and thus better communicate what the NAIC Commander considers important.

1.4 Scope

This research is not attempting to replace the NAIC Commander's sound judgment, but instead it is intended to provide some valuable insight into the extremely difficult decision of resource allocation. Although the research deals with NAIC's specific budget situation, this methodology can be applied to other resource allocation decisions within downsizing environments. The resources that are being looked into include both contracts and General Defense Intelligence Program (GDIP) personnel positions. This research, however, is limited to evaluating the impact of cutting these resources, and does not look into the effect of an *increasing* supply of money or people.

Rather than looking at the total impact of complete portfolio alternatives, which includes 60 contract and 1343 personnel decisions, this research broke down the overall decision into individual components. By evaluating specific contract and personnel decisions individually, the decision situation is simplified. This simplification, however, does not take dependencies into account; in fact, it assumes that each of these decisions is made independent of the others. Because of this limitation, significant efforts are made to address the issues of dependencies and ensure that, if identified by the experts, the

dependencies are included in the final analysis. Additionally, it should be noted that the research is deterministic in nature and that all evaluations are considered certainties.

1.5 Overview of Thesis

Chapter II presents a brief literature review that emphasizes alternative resource allocation techniques, as well as an overview of Decision Analysis, Value-Focused Thinking and the Excel Solver software. A quick review of the "Knapsack" problem, which is used to obtain optimal alternatives, is also given. Chapter III describes the methodology that was used to model NAIC's decision situation, including how the value hierarchy was built and how the alternatives were scored. Chapter IV is where the results of the analysis are located. This includes how to rank and select the best alternatives, in addition to the presentation of sensitivity analysis. Chapter V draws conclusions from the analysis and makes recommendations on future research within this discipline of Operations Research, as well as the use of this model by the NAIC Commander.

Lastly, this research is designed to insert objectivity, minimize the effects due to political motivations and provide improved alternatives in a timely fashion. Because of the inherent objectivity, this analysis should yield meaningful justification to a selected alternative which minimizes the impact on NAIC.

II. Literature Review

2.1 Overview

Before moving into the discussion of the model and its results, it is imperative to understand the intricacies of NAIC's situation, focusing on the resource allocation process that NAIC currently employs, and specific issues that outline the research effort. Next, resource allocation techniques that have been used in other military situations, as well as in the business world, are addressed. Value-focused thinking is presented in greater detail, followed by a review of the modeling software. Lastly, the knapsack problem is addressed as it pertains to this research effort.

2.2 Current NAIC Resource Allocation Process

Because of reduced resources within the last few years, NAIC came to a point where they had to decide whether to continue to provide one-of-a-kind "tailored air and space intelligence products and services (12:1)" at a reduced capability or to eliminate entire mission areas to accommodate the trimmed budget.

> "In the 1995 and 1996 Master Plans, [NAIC] made the decision not to quit doing any of [its] mission responsibilities or lanes in the road (i.e., capabilities such as Fighters, MRBMs, TACAIR FIS Processing). Instead the choice was to maintain some capability in all of [its] mission areas, but reduce [its] capacity (i.e., the number of products or the scope of the products) within a given mission area" (13:1).

This approach forced NAIC into identifying the areas where the workload could be adjusted with the least impact rather than losing the ability to satisfy an entire area of responsibility. The NAIC Commander would issue policy guidance and budget constraints to his Senior Management Team (SMT) and solicit proposals from them. After receiving the proposals, the Commander would assemble a plan for the upcoming budget and manpower cuts. This finalized plan could either be an exact replica of one of the SMT's proposals, a composite of many or one based on his own ideas.

For the FY00 program submission, 49 people and $8.716 million have been identified as the target reductions which this research helps analyze. NAIC has five divisions of resources, including Manpower, Contracts (external assistance), Research and Development (R&D), Operations and Maintenance (O&M), and Procurement. Figure 2.1 shows the breakdown of how much money is devoted to each of the divisions. Rather than looking at each of these five divisions, NAIC asked that the analysis focus on taking the reductions from only two areas—Manpower and Contracts.

Manpower designates the amount of money used towards the salaries of NAIC personnel. It is important to note that this part of the budget does not include money used for TDYs, training, etc. Contracts (external assistance) consist of specific items from an external source for which NAIC personnel request information for use by NAIC. This research is intended to assist the Commander in making these difficult downsizing choices.

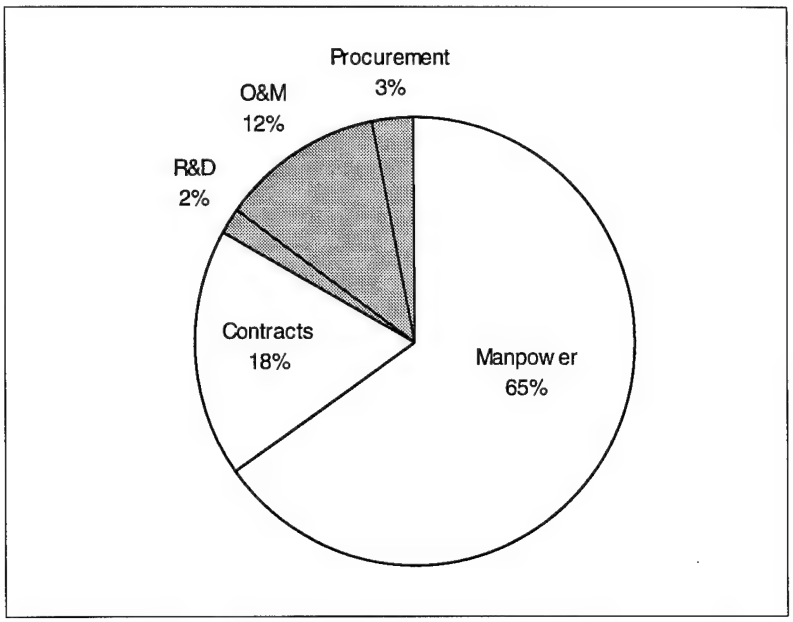


Figure 2.1 NAIC Budget Breakdown

2.3 Resource Allocation and Valuation Strategies

Virtually all of the organizations within the DoD have felt the sting of downsizing and annually attempt to maximize their output from a limited amount of resources. There are numerous examples of resource allocation efforts that validate the idea that there is no single approved method for making these allocation decisions. Because of the widespread downsizing in military organizations, as well as civilian businesses, resource allocation has become a very hot topic of debate. So much so in fact ,that Langholtz, Ball, Sopchak and Auble recently studied how people make resource allocation decisions "by examining how people perform complex but commonplace problems using a discrete scale where optimal solutions are determined with Integer Programming" (9:249). Their study reported that people were capable of solving simple two-dimensional resource

allocation problems. As the complexity increased, however, the participants' performance, measured by percent of optimality, diminished.

Many different methodologies have been used to identify and evaluate alternatives in resource allocation scenarios. A linear programming technique called the Exercise Support Program (ESP) Model was developed and used "to provide decision alternatives" and "enhance the information available to the decision maker in a manpower resource allocation exercise" (2:14). In the Harvard Business Review, Timothy Luehrman describes how resource allocation can vary (10:132).

> "Most companies use a mix of approaches to estimate value. Some methodologies are formal, comprising a theory and a model; others are informal, operating by ad hoc rules of thumb. Some are applied explicitly, and others implicitly. They may be personalized by individual executives' styles and tastes or institutionalized in a system with procedures and manuals."

No matter how the alternatives were created, nor how good or bad these alternatives are, selecting the best alternative is the goal of every competent decision maker. After all, "how a company estimates value is a critical determinant of how it allocates resources. And the allocation of resources, in turn is a key driver of a company's overall performance" (10:132).

Companies around the world are coming to the conclusion that the decision maker's personal experience is not sufficient enough to maximize the company's growth. "The absence of a formal valuation procedure often gives rise to personal, informal procedures that can become highly politicized" (10:136). These informal procedures do

not typically yield the most effective ways to run a business, much less efficiently allocate the business' resources.

Many businesses are looking for methods to evaluate their current performance as well as how they could improve their performance. At Ciba Geigy, president and CEO Stan Sherman expressed a desire "to establish a priority system so that we were putting resources where we would be getting the most value as a whole" (16:48). They developed criteria associated with newly established categories and tied them to resource allocation, performance measurement and expectation, and management focus. Not only did their analysis provide significant insights regarding their resource allocation strategy, the process of stepping back gave their company a better focus on the customers, the market place and resource requirements.

Another method for measuring and motivating business-unit performance in industry is the balanced scorecard concept. The scorecard consists of four perspectives (financial, customer, internal business processes and learning and growth) which provide a picture of the company's current performance, while remaining focused on the future. The scorecard lists objectives, measures and targets for each perspective, and is designed to stress the linkages for attaining high levels of performance in related rather than isolated measures. Amoco Corporation, BellSouth, Hewlett-Packard, Rockwell International and Sears are among the many organizations that have incorporated this concept into their daily practices. Robert Kaplan and David Norton explained the usage of the balanced scorecard in Financial Executive (6:30).

> "While some companies use their balanced scorecards just for performance measurement, some managers have begun

> to integrate the scorecard into their planning and budgeting processes. Used this way, the scorecard helps managers align their business units, as well as their financial and physical resources, to the company's strategy."

The balanced scorecard concept assists companies in focusing on improvement and allows them to make decisions based on attainment of high levels of performance.

Occasionally, problems are so complicated and fuzzy in nature that they require subjective scoring from the so-called experts. In the European Journal of Operational Research, Ching-Hsue Cheng proposes the use of the Analytical Hierarchy Process (AHP) in evaluating naval tactical missile systems. He claims that "[D]uring the last decade the AHP has become one of the most widely used methods for the practical solution of numerous ranking problems in different areas of human needs and interests" (3:343). This method represents the problem in a hierarchical form and uses pairwise comparisons and eigenvectors to rank different alternatives.

Historically, companies have based product or product line decisions primarily on market indicators and profits. This theory has taken a decided turn lately in that health and environmental risks have occasionally become more important to the success of the product. Total Quality Environmental Management published an article that describes a product stewardship strategy for incorporating these non-profit issues into the equation. Although it seems to be an evaluation tool in its infancy compared to the methods described earlier, it does emphasize the importance of non-profit objectives versus those of solely profits. This tool utilizes a two-dimensional table which is split into four areas. One axis is used to describe the product's competitive advantage, while the other axis denotes the environmental vulnerability. Each product gets scored as either "high" or

"low" on both axes, thus getting placed into the one of four bins. Each bin has an appropriate recommendation as to whether or not the particular product should be pursued (14). This last method certainly would not be classified as a highly technical valuation method, but it does force the company to focus on different objectives and values.

As shown, these difficult resource allocation decisions are not limited to just NAIC, nor the Department of Defense. Most businesses, in fact, face these questions on a continual basis. Various evaluation methods were presented and most of them boil down to the following: "If you really care about a decision, objectives are worth deep and serious thought" (7:55).

2.4 Decision Analysis

"Although decision analysis (DA) provides structure and guidance for systematic thinking in difficult situations, it does not claim to recommend an alternative that must be blindly accepted" (4:4). This points to exactly what this research is trying to do—assist the NAIC Commander to better understand his decision situation. The iterative approach of DA may be best explained through Figure 2.2 (4:6) below. Even though most decision analysis techniques revolve around the comparison of alternatives, DA is being used to focus the research on the Commander's values and evaluate how each alternative will impact NAIC. For this reason, the main thrust of the research is centered on the evaluation of alternatives. The most important final result of the analysis, however, is not

an exact answer to the problem, but instead a ranked ordering of solutions that can be used as a reliable guide for the Commander.

2.5 Value-Focused Thinking

In the book, Value Focused Thinking, Ralph Keeney claims that, "[I]n the more usual approach, which I refer to as alternative-focused thinking, you first figure out what alternatives are available and then choose the best of the lot. With value-focused thinking, you should end up much closer to getting all of what you want" (7:4). The theory behind value-focused thinking (VFT) is simple—rather than identifying alternatives from the beginning, start instead by examining what is important to the decision maker.

Not only does this focus the attention on the values that are important, these values serve as the quantitative measures by which alternatives are scored. Keeney points out that there are numerous other benefits of VFT, and they are shown in Figure 2.3. VFT is the main approach used in this research on NAIC's resource allocation process. The most important issue that VFT supplies guidance for is the identification of objectives, originating with the overall objective of minimizing the impact of reduced resources on NAIC. "The primary goal is viewed as the combined achievement of some set of fundamental objectives. Each fundamental objective is broken into subobjectives, which in turn, are broken into sub-subobjectives until a complete model of the decision maker's objective hierarchy, called a value model, is created" (15:6). The lowest levels

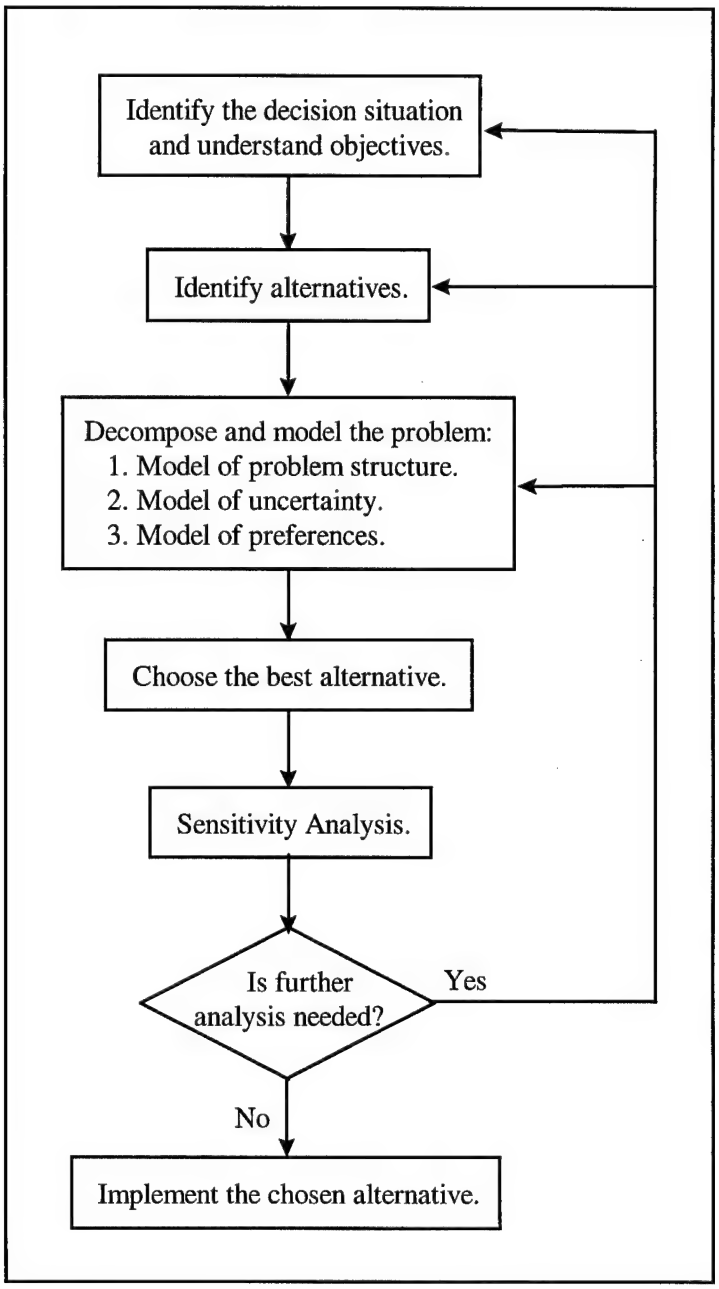


Figure 2.2 Decision Analysis Flowchart

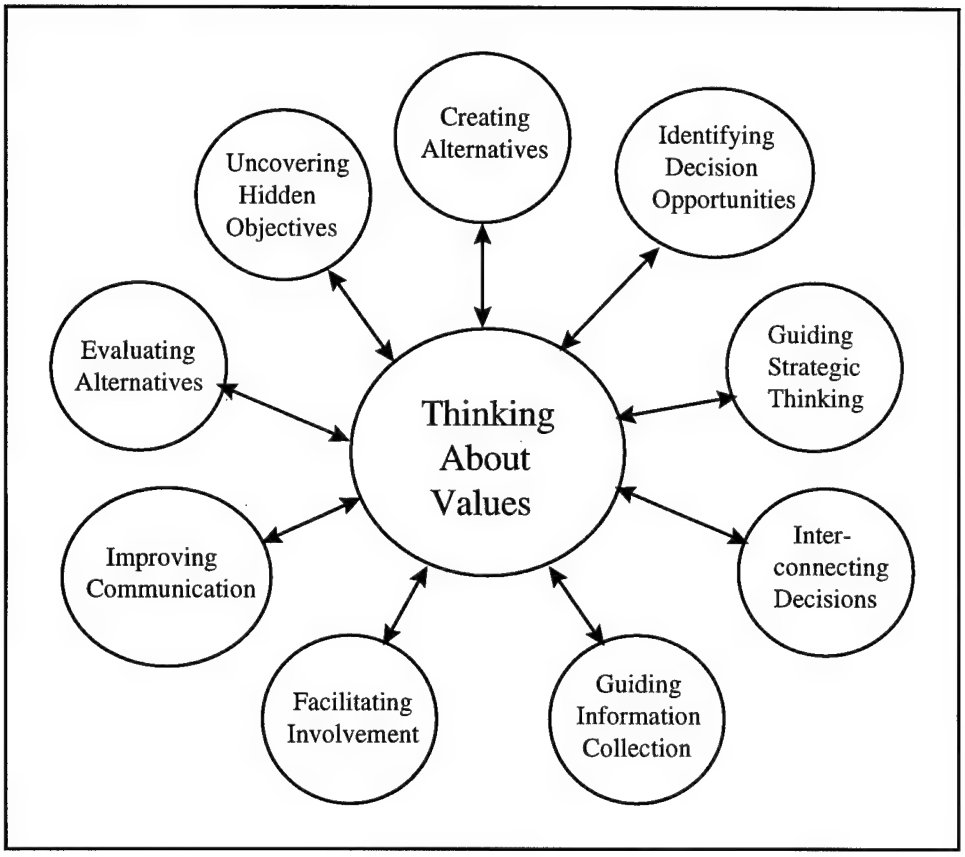


Figure 2.3 Benefits of Value-Focused Thinking

of each branch of the value model are called attributes or measures. Each attribute is evaluated for each contract or manpower decision, using a scoring function.

It is important to note that the value hierarchy should be complete and nonredundant. "For a value hierarchy to be complete, the evaluation considerations at each layer (tier) in the hierarchy, taken together as a group, must adequately cover all concerns necessary to evaluate the overall objective of the decision. [Additionally,] the evaluation measures for the lowest-tier evaluation considerations [must] adequately measure the degree of attainment of their associated objectives" (8:16).

Nonredundancy is another desirable property for a value hierarchy—no two objectives should overlap. In other words, properties of an alternative should be assessed by only one evaluation consideration. When a value hierarchy upholds the completeness and nonredundancy properties, it is typical to describe the value hierarchy as collectively exhaustive and mutually exclusive. The Commander's value hierarchy does indeed satisfy these two properties (8:17).

In addition to the development of the value hierarchy, VFT is vital to the aggregation of the scores. After the individual contract or manpower components are scored by NAIC, the scores are translated into a total impact for each component using the weights produced by VFT. The intricacies of scoring and aggregation are looked at in greater detail in Chapter III.

2.6 Excel Solver

Microsoft Excel was used for storing data and modeling the problem. Besides the fact that it is extremely user-friendly, it has the capability to solve a linear program (LP) within a spreadsheet. Because of its ability to manipulate numbers, Excel was used for calculating the scores for each of the contracts and manpower levels. Thus, only one software package was required. This reduced the amount of time required to run the LP and eliminated the additional input/output requirement when transferring data from one package to another.

2.7 Knapsack Problem

Although the ranking of alternatives was the main objective, a modified knapsack problem was used to identify an optimal strategy. The classic knapsack problem is an integer program "that has only one constraint" (17:468). This modified knapsack problem includes other constraints which limit the types of resources that are allowable in the feasible solution, and can be augmented by additional constraints based on input by the NAIC Commander.

2.8 Summary

This chapter reviewed NAIC's current methodology for allocating resources, along with numerous methods that others use for both resource allocation and evaluation of alternatives. An overview of decision analysis and value-focused thinking was also presented, followed by a quick look at the software used to model the problem and the type of integer program that was implemented.

III. Methodology

3.1 Overview

This chapter focuses on the methodology associated with executing the steps of the decision analysis flowchart shown in Figure 2.2. The actual results and accompanying analysis are presented in Chapter IV. The following decision analysis steps, from Figure 2.2, are discussed in sections 3.2-3.9: identifying the decision situation, understanding the objectives, identifying the alternatives, decomposition and modeling of the problem, choosing the best alternative, sensitivity analysis, and further analysis.

3.2 Identifying the Decision Situation

The challenge in identifying the decision situation is selecting the best possible resource allocation strategy—identifying which contracts and personnel should be funded during the target fiscal year. This is a difficult task even without the constraints which require NAIC to identify at least 49 personnel billets and at least $8.716 million to cut.

For the purposes of this research, NAIC has been divided into 18 distinct organizations. Each of these organizations has personnel billets, ranging between 41 and 141, that are exposed to the possibility of a reduction. The actual General Defense Intelligence Program (GDIP) personnel billets are shown in Table 3.1.

Table 3.1 Organization Personnel Breakdown

Org #	Officer	Airmen	Civilian	Total
1	31	0	42	73
2	29	0	38	67
3	25	0	33	58
4	21	0	34	55
5	22	0	47	69
6	35	7	66	108
7	7	6	68	81
8	12	12	22	46
9	16	19	92	127
10	20	23	98	141
11	32	18	49	99
12	10	8	64	82
13	5	8	30	43
14	17	9	23	49
15	3	16	57	76
16	20	1	26	47
17	14	0	27	41
18	9	15	57	81
Totals	328	142	873	1343

To NAIC's benefit, the AIA allowed the salaries of the personnel cut by NAIC to be included with the contract amounts to help satisfy NAIC's $8.716 million reduction.

For each of the 60 contracts evaluated, there are two levels that are evaluated—fully funded or completely cut. Because a fully funded contract is assumed to have no impact on NAIC—it is the baseline—only the "completely cut" option is evaluated by the responsible organization. The organization that can best determine the impact of an eliminated contract upon the NAIC mission is responsible for evaluating the contract. Each of these contracts are linked to only one responsible organization. For example, organization 1 controls six contracts (1A-1F), and is the responsible organization for evaluation. Table 3.2 shows the target year dollar amounts for each of the contracts.

Table 3.2 Contract Values
(in thousands of dollars)

Contract	Dollars	Contract	Dollars	Contract	Dollars	Contract	Dollars	Contract	Dollars
1A	549	2G	728	6B	507	10D	282	11G	322
1B	354	2H	266	6C	252	10E	527	11H	921
1C	767	3A	129	6D	67	10F	133	11I	461
1D	429	4A	229	7A	948	10G	38	11J	921
1E	266	4B	492	7C	89	10H	231	11K	231
1F	215	4C	893	7D	269	10I	759	11L	967
2A	112	4D	252	7E	891	11A	728	11M	593
2B	428	4E	347	8A	792	11B	286	11N	1842
2C	384	5A	507	9A	354	11C	692	11O	1685
2D	198	5B	462	10A	290	11D	180	11P	92
2E	112	5C	1288	10B	720	11E	318	11Q	223
2F	408	6A	133	10C	481	11F	1842	11R	157

As can be seen in Table 3.2, only organizations 1-11 are responsible for contracts—organizations 12-18 are not responsible for any contracts.

3.3 Understanding the Objectives

The next step, which lays the groundwork for the actual scoring of alternatives, uses Keeney's Value-Focused Thinking to assess the decision maker's values (7). A common method for visualizing the decision maker's values is called a value hierarchy or value tree. A value tree includes "evaluation considerations, objectives and evaluation measures" (8:15). A value tree is developed for the Commander of NAIC and described later in this chapter.

Given that the manpower and budget cuts must be reached, the overall objective function of NAIC's problem is to minimize the impact of these cuts on NAIC. This

represents the highest level of our value hierarchy or tree, and is where the value model begins. Captain Sandra Smith explained the value model by saying that it:

> "can be depicted as a tree hierarchy representing a fundamental objective repeatedly divided into subobjectives until quantifiable attributes are reached at the lowest tier. This tree representation allows insight into the role each element of the hierarchy plays in contributing to the overall objective" (15:17).

A branch proceeds down when more than one sub-objective helps describe the parent sub-objective. When exactly one measure can capture the essence of the sub-objective, that becomes the last sub-objective on a branch and is a measure. The two main ingredients of a value model are the actual values within the hierarchy and the weights that show the decision maker's preferences for each of those values. The methodology for identifying the Commander's values is described in Section 3.4, while the approach used for assessing the Commander's preferences for those values is described in Section 3.6.4.

3.4 Values

Prior to meeting with the Commander of NAIC, a sample value hierarchy, without weights, was prepared in order to reduce the amount of time required of the Commander. This "straw-man" value hierarchy, which conformed to the aforementioned principles of VFT, was primarily based on the previous Commander's values. It was constructed by Captain Steve Cox (5:60-74) and is shown in Appendix A. With the help of NAIC personnel, modifications were made prior to the meeting in order to accurately represent changes in NAIC's focus areas.

We worked with the Commander to modify the "straw-man" tree to more accurately represent the structure of *his* values. These changes were encouraged to ensure that the resultant hierarchy represented *his* values and preferences, as opposed to those of the former Commander. The approach used to evaluate the current Commander's values is referred to as top-down or objectives-driven (8:21). This approach focuses on the overall objective of minimizing the negative impact on NAIC, and develops sub-objectives with successively more detail moving down the tree.

The meeting resulted in a modified hierarchy which accurately represents the current Commander's values and objectives (1). Figure 3.1 shows the top three levels of his value hierarchy.

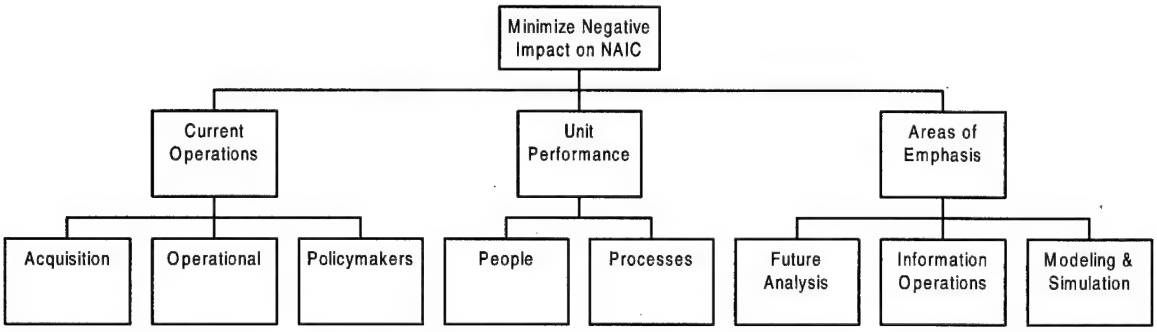


Figure 3.1 Top Three Levels of Value Hierarchy

3.5 Identifying the Alternatives

An alternative is defined as any combination of the 78 decisions—60 fund or cut contract decisions (0% or 100% cut) and 18 personnel percentage decisions (0%, 5%, 10%, 15% or 20% cut). Reasons for using 5% intervals for the manpower reductions is

discussed in Section 3.6.6. If the total dollar amount cut must be at least $8.716 million *and* at least 49 personnel billets are chosen to be cut, the alternative meets the downsizing criteria and is considered feasible. Even with the budget and manpower constraints, the number of feasible alternatives does not decrease significantly—cutting the $10^{30.6}$ alternatives to a conservative estimate of half of that number. Obviously, calculating each of these alternatives separately would not be practical. How this problem was dealt with is also discussed in Section 3.6.6.

Although all feasible alternatives are possible candidates, most of them are dominated by other alternatives and are therefore alternatives not worth consideration. There are, however, at the Commander's request, feasible proposals that were provided by members of his Senior Management Team. These proposals are among the numerous feasible alternatives described above, and are compared to the optimal integer program solution in Chapters IV and V.

3.6 Decomposing and Modeling of the Problem

"The idea of modeling is critical in decision analysis, as it is in most quantitative or analytical approaches to problems" (4:7). The decomposition of the problem began with the assessment of the Commander's value hierarchy. The following topics deal with the decomposition and modeling of the problem and are addressed in the remainder of Section 3.6: scoring of alternatives, manpower variations, model type and independence.

3.6.1 Measure Identification

In actuality, the evaluation considerations to be measured were already identified when the value hierarchy was developed. Each higher level objective was broken down into lower levels if there was not a single measure that could capture the essence of that objective. When a single measurable quality could fully address the parent objective, that sub-objective became the measure. Once each branch of the value hierarchy was broken down fully, the measures to be evaluated were determined. The "Current Operations" branch of the value tree, pictured in Figure 3.2, helps reveal the difference between sub-objectives which are measures (bold border lines) and sub-objectives which need to be further broken down.

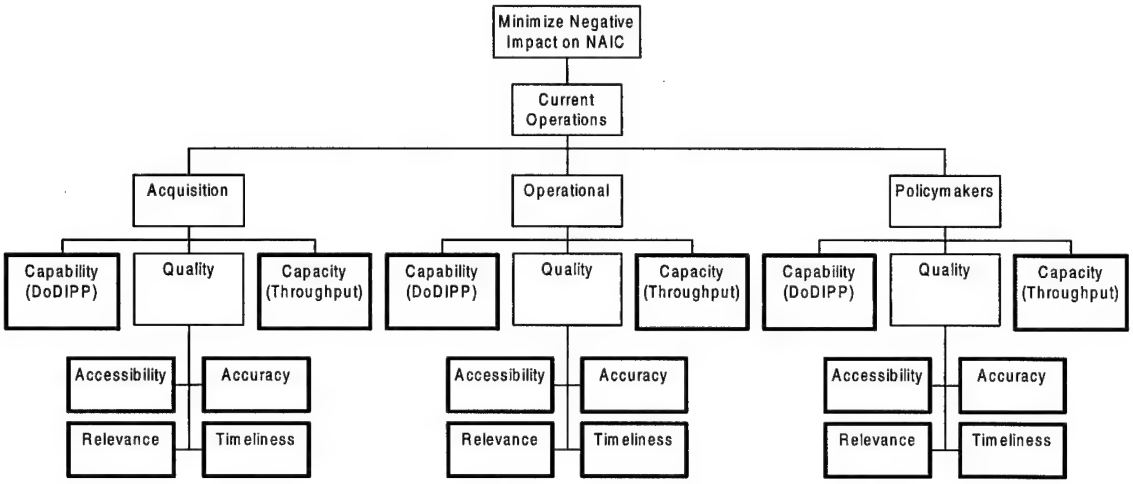


Figure 3.2 Measures Within the "Current Operations" Branch

Under the "Acquisition" branch, "Capability (DoDIPP)" and "Capacity (Throughput)" are sub-objectives that, because they are at the lowest level of the hierarchy, are measures

that will be scored. They are not broken down any further since the sub-objective can be accurately assessed by one scoring measure. The Commander determined that "Quality", on the other hand, could not be precisely evaluated with one scoring measure, and therefore should be broken down. The necessity for a further dissection of the "Quality" sub-objective resulted in the development of four quantifiable measures, with the combination of the four representing the parent sub-objective. The continuation of this process throughout the entire value hierarchy produced 49 measures, all of which are used to compare each contract and manpower decision. In Appendix B, measures are located at the bottom of the fathomed branches and are designated by bold border lines.

3.6.2 Scoring Measures

Once the measures are identified, it is necessary to determine a method for evaluating how well the alternatives score against them. By using a scoring function for each measure, the alternative's performance should be accurately translated into an array of quantitative scores. A scoring function consists of two axes and a translating curve, or single dimensional value function, linking the axes to one another.

For each measure's scoring function, the x-axis has a range that encompasses all of the possible scores of interest. This score is translated to the y-axis using a measure-specific curve, which should take into account any returns to scale. If the decision maker does not believe that each equal movement along the measure's x-axis attains the same value, the scoring function would exhibit increasing or decreasing returns to scale. On the other hand, if the decision maker does believe that value is equally gained, no matter

where the scores are on the x-axis, the scoring function would be linear. No matter which type of scoring function applies, it is positioned above the x-axis and is used to translate the performance of an alternative into a quantitative score. Once all of the measures are translated into numbers, the scores "are weighted by a product of the weights at the [associated] levels in the value tree" (4:557). The value model mathematics are displayed in Equation 3.1 below (8:230):

$$\mathbf{V(x)} = \sum_{i=1}^{n} \lambda_i v_i(x_i)$$

$$\sum_{i=1}^{n} \lambda_i = 1$$

$$\lambda_i \geq 0 \; \forall \; i = 1,\ldots,n$$

x_i = Score for the i^{th} measure of merit
n = Total number of measures of merit
$v_i(x_i)$ = Scoring function for i^{th} measure of merit
λ_i = Weight of i^{th} measure of merit (product of weights up the hierarchy)
V(x) = Value of impact on NAIC of one contract or manpower cut

Equation 3.1 Value Model Equation

The additive value function, **V(x)**, is the quantitative amount of impact that the contract or manpower cut, if taken, would have on NAIC. The Commander's weights for a specific measure is designated by λ_i, while the single dimensional value function for each attribute is $v_i(x_i)$. The methodology used to assess the Commander's weights or preferences is described in Section 3.6.4. Before using the additive value function for NAIC's particular problem, we must satisfy independence conditions. A detailed examination of this issue is provided in Section 3.6.3, immediately following the description of how the scoring measures are implemented in NAIC's case.

Each of the 49 measures used an x-axis similar to the one shown in Figure 3.3. The organizations in charge of the contract or manpower placed an 'X' on the line scale, delineating the amount of affect that the cut would have on that particular attribute. A listing of the 49 "contract" x-axes are displayed in Appendix C. Because the value hierarchy represents the Commander's values, it does not require significant alterations when used for manpower level scoring instead of contracts. Only small modifications in the wording of each scoring measure is necessary. The beginning of each scoring measure is changed from "If this contract is cut..." to "For each manpower reduction...".

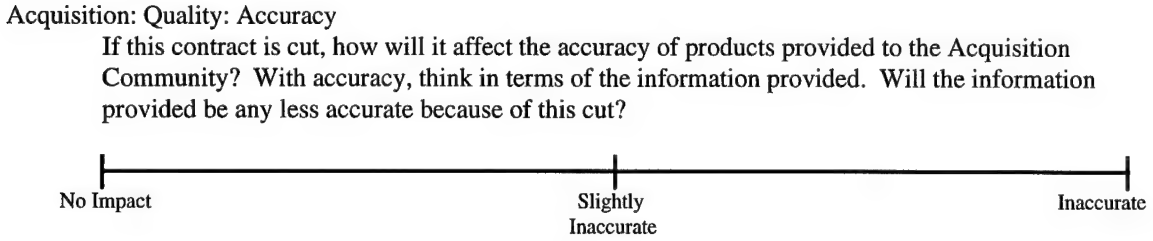


Figure 3.3 Line Scale for "Accuracy" Measure

After the contracts and manpower level scores were returned from NAIC, the exact placement of the 'X' was manually transferred into a utility score by the analyst. These translations utilized single dimensional value functions, which were determined to be linear in nature. An example of the single dimensional value function is provided in Appendix D. In order to produce easily understood contract and manpower level scores, it was determined, by a representative of the decision maker, that a range of 0 to 10 should be used. In fact, the range used does not matter, as long as it is consistent along all of the measures.

Once the 49 attribute scores were collected for a contract or manpower level, an aggregate score could be calculated by simply summing the products of the attribute scores and the Commander's weighted preference for that specific measure. This aggregate score is the amount of negative impact on NAIC caused by the elimination of the contract or manpower positions. It is important to note that the initial impacts were scored as though they were totally independent of one another. In essence, each contract or manpower level was scored as if it was the only reduction.

Because of the linearity associated with the single dimensional value functions, it is permissible to add the additive value functions for separate contracts and manpower levels together to arrive at an alternative's overall impact on NAIC. This aggregation, however, only holds true if the scores are accurate. This is not necessarily true because of the initial assumption that the contract and manpower levels were assumed to be independent of one another. The issue of scoring dependence is addressed in Section 3.6.6.4.

3.6.3 Mutual Preferential Independence

Because NAIC's problem does not involve uncertainty, mutual preferential independence is the condition that is required for the additive value function to be appropriate (4:580). Preferential independence occurs when the decision maker's preference for one attribute does not depend on the level of the second attribute. For example, it does not matter how good an organization's safety is, the preference for the amount of training is always the same. Mutual preferential independence is satisfied

when preferential independence is attained for both scenarios—the preference for the organization's safety also does not depend on the level of training within the organization.

Clemen states that it "probably is fair to say that mutual preferential independence holds for many people and many situations, or that at least it is a reasonable approximation" (4:579). Kirkwood adds that the "additive value function has been widely used in practice. However, the formal assessment procedure specified above is not often used" (8:240). Since a decomposable hierarchy was developed for NAIC, mutual preferential independence is a safe assumption.

3.6.4 Weights/Preferences

At this point, the assessment of the Commander's preferences can begin. The importance of weighting each level of the hierarchy lies in determining the contribution to the parent objective, relative to other sub-objectives on the same level within that branch. A branch is defined as a connected part of the tree that proceeds downward, while a level is the set of sub-objectives that describe the objective directly above them on the same branch. On the second tier of Figure 3.1, there exists three separate branches—Current Operations, Unit Performance and Areas of Emphasis. Because they have the same parent objective (Commander's Values), they each are assigned a preference or weight based on the percent contribution to the parent objective, with the sum of the three sub-objectives equaling 100%. The following scenario describes the direct assessment methodology facilitating the assignment of weights or preferences.

> "You have 100 marbles. These marbles can be distributed in any manner you want. At each level in the hierarchy you have an additional 100 marbles. Once all the marbles are gone, there are no more for that level. Consider [Current Operations], [Areas of Emphasis], and Unit Performance. How would you distribute those 100 marbles?" (5: 21)

By performing this scenario on each of the levels in each of the branches, a weighted value model, known as a value hierarchy, is developed and utilized to score the alternatives.

Due to time constraints, the Commander evaluated most of the weights within his value hierarchy on his own. The completed value model represented his values, preferences, and objectives at NAIC. The top three levels of his weighted value hierarchy are shown in Figure 3.4.

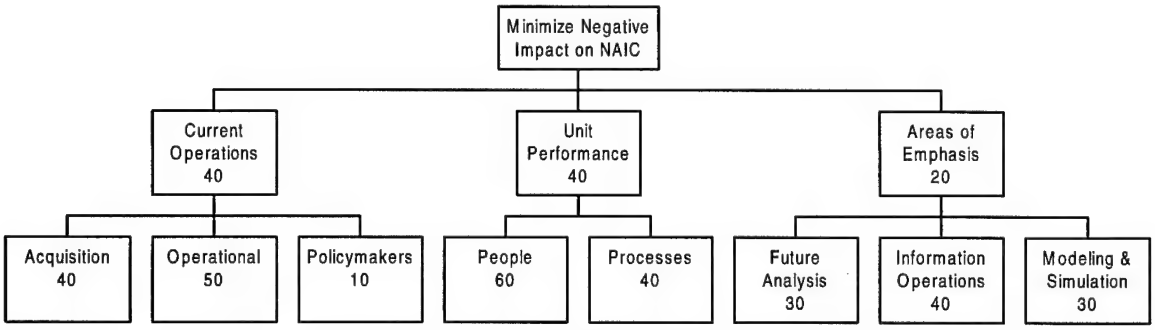


Figure 3.4 Top Three Levels of Value Hierarchy with Preferences

By looking at the second tier of the Commander's hierarchy, it is evident that "Current Operations" is equally (40% to 40%) as important to the overall objective of minimizing negative impact on NAIC as "Unit Performance". Additionally, the Commander considers both "Current Operations and "Unit Performance" to be twice

(40% to 20%) as important as "Areas of Emphasis".

It is extremely important to note that although the current value hierarchy originated from the previous Commander, it was modified and is now an accurate representation of the current Commander's values. The complete version of the current Commander's value hierarchy, including each of the weighted sub-objectives and attributes, is presented in Appendix B.

3.6.5 Model Structure

With the Commander's values accurately portrayed in the hierarchy and the scoring measures identified, the structure of the model begins to become clear. By assuming that each of the different decisions are independent of one another, an integer program can be used to find the best alternative for the independent case. This moves the focus away from evaluating complete alternatives, and concentrates efforts on the individual contract and manpower scores. With this time-saving technique, however, comes the issue of having to deal with independence.

After discussions with NAIC, it is believed that for the most part, independence is not a bad assumption. However, rather than accepting independence as a reality, procedures are in place to account for any interdependencies. They are described in Section 3.6.4.4. Before describing the manpower variations, it should be reiterated that this research deals only with the reduction of the contract and manpower resources, not the addition of these resources. Different single dimensional value functions would possibly be needed for additions of either resource. Besides, the measures and scales

were developed for existing contracts and manpower levels and do not represent what "could" occur with respect to unknown contracts/manpower additions.

3.6.6 Manpower Variations

Even though the methods for evaluating contract and manpower decisions have their differences, the scoring sheets and scoring methodology for the 49 measures are still applied to both the contract and manpower level cuts. The reason for this is that the value model is not contract or personnel specific. Instead, the value model indicates what is important to the Commander, regardless of the type of resource. The four main differences that require further explanation are: 1) number of possible cut levels, 2) size of cut levels, 3) mixture of personnel to be cut, and 4) dependencies.

3.6.6.1 Number of Possible Cut Levels

Although efficient, an "all or nothing" decision is not appropriate for identifying manpower reductions. On the other hand, evaluating each of the 1343 personnel billets in NAIC would be remarkably accurate, but extremely time consuming for both NAIC and an analyst. Each level of manpower reduction is evaluated by assessing each of the 49 attributes. Exactly one level per organization is chosen. Obviously when choosing the number of levels to model, a trade-off between accuracy and efficiency is required. Knowing how quickly the number of alternatives increase with the number of cut

levels—an increase from 5 levels to 6 causes a 26-fold increase in the number of alternatives—a five-level breakdown was chosen with the help of NAIC representatives.

3.6.6.2 Size of Cut Levels

Believing that five levels achieved an acceptable mix of accuracy and completion time, the choice turned to identifying an appropriate number of personnel cut at each level. The main issue at stake is ensuring that the range encompasses all of the plausible options, while keeping the gaps between two levels to a minimum. Due to the variance in the number of personnel per organization, percentages were chosen rather than using actual numbers. It was determined by NAIC representatives, and confirmed by the Commander, that, barring extreme cases, none of the organizations would realistically be asked to take a cut of more than approximately 20%. For this reason, the five manpower reduction levels used in this research were the closest integer number of people between 0% and 20%, at 5% intervals. Like a fully funded contract, the 0% personnel reduction level is the baseline, requiring no effort on the part of the functional experts, and therefore, receives a score of zero impact. For this reason, only four manpower levels are required to be evaluated by each organization, producing 72 (4 levels for each of the 18 organizations) vectors of scores.

3.6.6.3 Mixture of Personnel to be Cut

With the number and size of reduction levels identified, the research must define which personnel billets to cut. Intuitively, it makes sense that the impacts, as well as the salaries of the NAIC personnel, are not equivalent throughout the organization. For this reason, the methodology needed to account for the individual differences while keeping the problem size practical. Once again, a trade-off between accuracy and completion time was required.

Another issue that needed to be addressed is the merit of the manpower cuts, themselves. In order for this research to attain the absolute best answer, the responsible organizations would have to select the optimal breakdown for each manpower levels within the 18 organizations. After all, this research makes decisions based on the proposed manpower cuts. Theoretically, this research approach could be used by the 18 individual organizations to minimize the impact on NAIC caused by manpower cuts *within* each individual organization. Essentially, the same methodology would be used—just on a smaller scale with slight modifications required when implementing.

Because of time limitations, the breakdowns for the manpower reductions for each specific organization were not ascertained using VFT. However, it is assumed that the optimal manpower levels could be accurately assessed by the organizational leaders.

In order to balance the time requirements and model accuracy, the organizations were asked to identify the number of officers, airmen and civilians they would cut at each level, instead of naming specific personnel. The breakdown of the General Defense Intelligence Program (GDIP) personnel in their organization was provided to them as a

reference. Lost in this simplification are the actual salaries of the affected personnel. For this research, NAIC averages were used for each of the three personnel classifications—Officers, Airmen and Civilians. These averages are shown in Table 3.3.

Table 3.3 Average Salary Breakdown

Category	Average Salary
OFFICER	$88,000
AIRMAN	$39,000
CIVILIAN	$65,000

Using organization 1 as an example, Table 3.4 shows the chart that was completed by each of the 18 organizations. The complete manpower breakdown sheet is displayed in Appendix E.

Table 3.4 Manpower Breakdown Chart

	# of Persons	Proposed			√ if Proposal Affects other	
#	To Be Cut	# of Off	# of Amn	# of Civ	Manpower	Contract
0	0	0	0	0	---	---
1	4	_____	_____	_____	_____	_____
2	7	_____	_____	_____	_____	_____
3	11	_____	_____	_____	_____	_____
4	15	_____	_____	_____	_____	_____

Org 1 Breakdown	
Officer	31
Airmen	0
Civilian	42
Total	73

Using the reductions proposed by the specific organizations produces a precise indication of which personnel billets would be cut. This, in turn, provided a fairly accurate assessment of the salaries for use in the constraints of the integer program.

3.6.6.4 Dependencies

The one section of Table 3.4 that has not been clarified is the "√ if Proposal Affects other" section. This section is where the interdependency issues are taken into consideration. After the organization identifies where the proposed reductions come from, they are instructed to identify whether or not there are any dependencies associated with the reduction of their personnel. In other words, they check the appropriate box if, by taking that particular cut, it would affect the manpower scores of other organizations and/or contract scores. For example, if a 15% reduction in the personnel of organization 1 would cause the evaluation of a contract or another organization's manpower level to change, dependency would be present and a "√" would be placed in the appropriate box on the 15% cut line (11 people cut).

In order to keep the amount of time required of NAIC leaders to a minimum, no further action is taken to remedy the dependencies until after the initial analysis is performed. The important part of the original dependency question is to find out whether or not dependency exists. The extent of the dependencies is not required until after a ranked ordering of the contracts and manpower levels is done. Explanation of when further analysis is required and how it is done is presented in Section 3.9.

3.7 Choosing the Best Alternative

Once all of the contracts and manpower reduction levels have been scored and translated into the Excel Solver, the integer program (IP) can be run. By satisfying the

budget constraints, the IP selects the alternative which minimizes the total impact on NAIC. The total impact on NAIC is defined in Equation 3.2. In addition to reporting the optimal alternative, a rank ordered list of the contracts and manpower reductions, using the impact-per-cost ratios, is helpful to the decision maker. Because this analysis is not designed to be a panacea, but instead another tool for the Commander to use, the ranked ordering may be the most useful result.

$$\text{Total Impact} = \sum_{i=1}^{60} \mathbf{V_C(i)}\,(X_i) + \sum_{i=1}^{18}\sum_{j=1}^{5} \mathbf{V_M(i_j)}\,(Y_{ij})$$

$\mathbf{V_C(i)}$ = Value of impact on NAIC due to cutting contract i

$X_i = 1$ if contract i is cut; 0 otherwise

$\mathbf{V_M(i_j)}$ = Value of impact on NAIC due to selecting manpower level j for organization i

$Y_{ij} = 1$ if manpower level j for organization i is selected; 0 otherwise

Equation 3.2 Total Impact Equation

3.8 Sensitivity Analysis

As is the case for most decision analysis projects, sensitivity analysis is essential to fully analyzing the problem. Within this research, there are two main areas where sensitivity analysis can be very useful to the decision maker—1) the Commander's preferences, and 2) the constraints on the problem. By performing sensitivity analysis on the weights assigned to the upper tier objectives, the Commander can visualize what happens if his preferences are not certain.

The constraints on the problem also may not be rigid. By examining the results of this type of sensitivity analysis, the decision maker could be led to selecting an alternative

that does not actually satisfy the original constraints. Obviously, moving outside the feasible region described by the original constraints is a choice that the decision maker has to make. Both of these types of sensitivity analysis provide the Commander more insight into the decision situation facing him and are addressed in Chapter IV. Giving the Commander a clearer understanding of the impacts associated with each alternative is a goal of the research, and is accomplished by performing the sensitivity analysis.

3.9 Modeling Dependency

Before identifying the best alternative, the interdependencies discussed earlier must be revisited. Recall that some of the manpower reduction levels may have indications of interdependencies. If any of these "checked" manpower reduction levels were chosen as part of the cuts in the initial solution, further analysis is required. The organization with the dependency is asked which contract and/or manpower organizations could be scored differently as a result of their manpower cuts. If the *other* organization agrees that their scoring would change, each of the dependent components (contracts and/or manpower levels) would be re-scored based on the assumption that the organization that checked the box was losing the specified number of people.

After going through this process, an updated optimal alternative and ranked ordering would be produced. The same "further analysis" would be re-accomplished if necessary, until a steady-state final solution is produced.

3.10 Summary

This chapter proceeded through the methodology of the entire Decision Analysis Flowchart, which includes the following: identifying the decision situation, understanding the objectives, identifying alternatives, decomposing and modeling the problem, choosing the best alternative, performing sensitivity analysis and further analysis. By implementing these steps, the NAIC Commander's value hierarchy was produced, along with the scoring measures and functions for evaluating the contract and manpower reduction choices. This methodology is used as the basis for achieving the results presented in Chapter IV.

IV. Results and Analysis

4.1 Overview

The objectives of this research were to help the NAIC Commander make the best resource allocation decision for the FY00 program submission (cut 49 people and cut $8.716 million) and provide NAIC's plans and policy office with a proven tool for use during future program submission cycles. This chapter provides the results and analysis of the implemented methodology, including the initial results (without dependencies), updated results (with dependencies) and sensitivity analysis.

4.2 Initial Results

As described in Chapter III, the initial analysis is done without taking dependencies into consideration. Recall that an alternative is defined as any combination of the 60 contract and 18 manpower decisions. Using an integer program within Excel, the alternative with the least negative impact on NAIC, also known as the initial optimal alternative, was determined. The initial model only has two types of constraints. The first type of constraint ensures that the required dollar and manpower reduction levels were attained while the second type of constraint mandated that exactly one of five manpower reduction levels was selected for each organization. This initial optimal alternative satisfies both types of constraints and is presented in Table 4.1. The addition of constraints is addressed in Section 4.6 of this chapter. The first two columns list the 60

contracts and whether they are fully funded or totally cut. The alpha-numeric designation lists the organization number, followed by a letter signifying the specific contract within that organization. For example, organization 1 has 6 contracts, listed as 1A, 1B, 1C, 1D, 1E and 1F.

The last three columns list the possible manpower level reductions. Unlike contracts, where there were only 11 responsible organizations represented, all 18 organizations were assessed for each of the five possible manpower reduction levels. Using organization 1 as an example, 1MA, 1MB, 1MC, 1MD and 1ME are the 0%, 5%, 10%, 15% and 20% manpower reduction levels, respectively, with exactly one reduction level chosen for each organization. The term "Cut" next to a contract means that contract was selected to be cut, while the term "Pick" identifies which manpower reduction levels were chosen as part of the optimal alternative.

As can be seen in Table 4.1, the initial optimal alternative included cutting four contracts (11F, 11K, 11N and 11O) and selecting five non-0% manpower levels (5% reductions for organizations 10 and 17, and 20% reductions for organizations 6, 13 and 14). The total impact on NAIC for this alternative is 7.105, with $8.853 million and 49 personnel positions cut. Table 4.2 presents a breakdown of where the impact, dollar and personnel totals specifically come from.

4.3 Identifying Dependencies

The dependencies are identified by the organizational leaders during the initial scoring, and accounted for as part of the updated analysis. After running the initial

Table 4.1 Initial Optimal Solution

Contract	Cut	Contract	Cut	Manpower	Pick	Manpower	Pick	Manpower	Pick
1A	-	7E	-	1MA	Pick	7MA	Pick	13MA	-
1B	-	8A	-	1MB	-	7MB	-	13MB	-
1C	-	9A	-	1MC	-	7MC	-	13MC	-
1D	-	10A	-	1MD	-	7MD	-	13MD	-
1E	-	10B	-	1ME	-	7ME	-	13ME	**Pick**
1F	-	10C	-	2MA	Pick	8MA	Pick	14MA	-
2A	-	10D	-	2MB	-	8MB	-	14MB	-
2B	-	10E	-	2MC	-	8MC	-	14MC	-
2C	-	10F	-	2MD	-	8MD	-	14MD	-
2D	-	10G	-	2ME	-	8ME	-	14ME	**Pick**
2E	-	10H	-	3MA	Pick	9MA	Pick	15MA	Pick
2F	-	10I	-	3MB	-	9MB	-	15MB	-
2G	-	11A	-	3MC	-	9MC	-	15MC	-
2H	-	11B	-	3MD	-	9MD	-	15MD	-
3A	-	11C	-	3ME	-	9ME	-	15ME	-
4A	-	11D	-	4MA	Pick	10MA	-	16MA	Pick
4B	-	11E	-	4MB	-	10MB	**Pick**	16MB	-
4C	-	11F	**Cut**	4MC	-	10MC	-	16MC	-
4D	-	11G	-	4MD	-	10MD	-	16MD	-
4E	-	11H	-	4ME	-	10ME	-	16ME	-
5A	-	11I	-	5MA	Pick	11MA	Pick	17MA	-
5B	-	11J	-	5MB	-	11MB	-	17MB	**Pick**
5C	-	11K	**Cut**	5MC	-	11MC	-	17MC	-
6A	-	11L	-	5MD	-	11MD	-	17MD	-
6B	-	11M	-	5ME	-	11ME	-	17ME	-
6C	-	11N	**Cut**	6MA	-	12MA	Pick	18MA	Pick
6D	-	11O	**Cut**	6MB	-	12MB	-	18MB	-
7A	-	11P	-	6MC	-	12MC	-	18MC	-
7C	-	11Q	-	6MD	-	12MD	-	18MD	-
7D	-	11R	-	6ME	**Pick**	12ME	-	18ME	-

Table 4.2 Breakdown of Impact, Dollar and Personnel Totals

Resource	Dollars Cut	Personnel Cut	Impact of Cut
Contract 11F	1842	0	1.204
Contract 11K	231	0	0.144
Contract 11N	1842	0	0.588
Contract 11O	1685	0	0.575
5% Manpower Cut in Org 10	452	7	0.929
5% Manpower Cut in Org 17	153	2	0.382
20% Manpower Cut in Org 6	1464	22	2.190
20% Manpower Cut in Org 13	517	8	0.797
20% Manpower Cut in Org 14	667	10	0.296
Totals	8853	49	7.105

model, the initial results were combined with the manpower reduction levels and contracts that had indications of dependencies to determine which organizations were required to re-score their resources. The 20% reduction of personnel in organization 14 was the only element selected in the initial optimal solution that exhibited dependencies. In order to reduce the likelihood of having to perform more iterations, another organization reduction level was chosen for further analysis. From the non-selected manpower levels with dependency indications, a 20% reduction of personnel in organization 3 was chosen because it had the lowest impact/cost ratio. In other words, among the non-selected dependent reduction levels, "3ME" is the most likely element to be a part of future sensitivity analysis alternatives. By quantifying how other elements are affected by the selection of these two reduction levels, the model can hopefully assess the overall impact of an alternative without having to perform multiple iterations.

Although the leader of organization 14 indicated that up to seven organizations could possibly be affected by a 20% cut of his personnel, the representatives of only two organizations—organizations 1 and 2—concurred with this dependency assessment. The proposed positions to be cut, identified by the leader of organization 14, were provided to each of the seven potentially dependent organizations. Because organizations 1 and 2 verified that their manpower level scoring would change if organization 14 reduced manpower by 20%, both leaders scored each of their four manpower levels again, with the assumption that organization 14 was taking a 20% reduction in personnel. The alpha-numeric designations for the dependent scores first list the organization and manpower reduction level being scored (like before), with the dependent organization listed last. For

example, 1MD14 would represent the impact associated with a 15% reduction of personnel in organization 1, given that a 20% reduction of personnel in organization 14 is chosen.

The same evaluation process occurred with respect to organization 3. Four of the six organizations possibly having dependencies on organization 3, agreed that their manpower scoring would change as a result of a selection of 3ME. The four organizations—numbers 1, 2, 16 and 17—re-scored their manpower levels based on the assumption that organization 3 was taking a 20% reduction in personnel. Like organization 14, no contracts were deemed dependent upon this manpower reduction level, and therefore, further analysis was limited to the manpower reduction levels of the organizations specified above.

These new manpower scores, in addition to the scores assuming independence, are included in the updated integer program. If a 20% reduction in personnel for either organization 3 or 14 is chosen, the new scores for the specified organizations are used. Otherwise, the original independent scores are used. The constraints used for modeling the dependencies were simple. Even though there were more than five possible choices for the dependent organizations, the selection of exactly one manpower level per organization still applied. By equating the sum of the five new dependent score binary variables to the binary variable for the 20% cut of 3 or 14, the constraints forced the IP to only look at the dependency level scores when the reduction level responsible for the dependencies was chosen.

Because organizations 1 and 2 are dependent on both 3 and 14, there exists a real possibility that an assessment of organizations 1 and 2 would be required for the combined dependency. The leader of organization 1 stated that the combined dependency impact for each attribute could be accurately assessed by using the maximum impact of either 1ME3 or 1ME14. Therefore, the scores for when both 3ME and 14ME were chosen is calculated using the highest of the two dependency impacts for each attribute. As one would expect, the selection of both 3ME and 14ME would result in an impact score (for organization 1) at least as high as each separate dependent score. The same ideology existed for organization 2, with regards to the combined dependencies. The integer program and resultant alternatives refer to this choice as 1MCX2—the impact of organization 1 taking a 10% reduction in personnel, given that both organizations 3 and 14 are taking 20% reductions.

The impact score for a 20% reduction in organizations 3 and 14 was assumed to account for any impact changes at the 0% level in all other organizations. This assumption accounts for potential impacts to the 0% manpower reduction level scores caused by the cuts to organizations 3 and 14. Because of this assumption, the 0% manpower reduction levels continue to have zero impact scores.

4.4 Integer Program Constraints

The modified knapsack problem included 20 constraints. The first two constraints ensure that the dollar and manpower requirements are met. The IP sums the dollar and personnel cuts for each of the contracts chosen to be cut and selected manpower reduction

levels. For an alternative to be feasible these sums must be greater than or equal to the reduction requirements.

Additionally, for each of the 18 organizations in NAIC, a constraint that states that exactly one of five manpower levels is selected is added. This is implemented by ensuring that the sum of the binary decision variables for each organization equals one. These 18 constraints, when combined with the two budget constraints, form the initial constraint set.

The incorporation of dependencies, however, cause the variable and constraint sets to grow. In fact, each dependency causes the IP to add five variables and one constraint, in addition to modifications to one of the initial constraints. Because a 20% manpower reduction in organization 14 caused organization 1 to be re-scored, five additional constraints were added to the initial five manpower reduction level constraints for organization 1. These ten binary decision variables for organization 1 must now sum to one, and thus removes the *initial* manpower constraint for organization 1.

The IP forces the correct constraint set (independent five or dependent five) to be used by equating the binary decision variable for a 20% manpower reduction level in organization 14 and the sum of the dependent set of manpower level decision variables in organization 1. Therefore, if the 20% manpower reduction level in organization 14 is chosen (its decision variable = 1), one of the dependent reduction levels for organization 1 is also chosen. By selecting one of the dependent reduction levels, the IP prohibits the selection of any of the five initial (independent) manpower reduction levels. For each of

the six dependencies in the model, corresponding variables and constraints are added to the IP.

Because organizations 1 and 2 are affected by 20% reduction levels for both organizations 3 and 14, a constraint is added to ensure that the correct dependency score is chosen. An additional fifteen variables are required to be added to the initial set of five. Ten of the fifteen are used to account for each separate dependency (five variables corresponding to each organization), while the remaining five variables correspond to the combined impact of simultaneous 20% cuts to both organization 3 and 14. The IP equates the decision variable of the 20% manpower reduction level for organization 3 with the sum of the ten reduction levels (includes five combined dependencies) associated with organization 3 dependency scores. The IP uses a similar constraint set to ensure that the dependencies associated with organization 14 are used when necessary. The combination of both sets of variables and constraints forces one of the five combined manpower reduction level scores to be selected when the 20% manpower reduction level is chosen for both organizations 3 and 14.

4.5 Updated Results

After these dependencies were quantified and represented appropriately in the mathematical program, the updated integer program is used to find an optimal solution. Note that if an updated alternative includes the selection of a different organization manpower level, which exhibits the dependencies that organizations 3 and 14 did, the same process of accounting for these dependencies would be required. The inclusion of

the 20% reduction to organization 3 dependency was done to prevent the requirement of performing a third iteration.

The updated integer program resulted in the same optimal alternative as the independent model. The reason for this is that none of the dependent manpower reduction levels were included in the solution of the independent case. The sets of dependent scores do not enter the optimal alternative because their impact is greater than they were in the independent case.

Because this research is designed to *help* the Commander make a more-informed decision in *his* decision environment, the initial optimal solution from Table 4.1 may not be the implemented decision. Being able to model almost any constraint in a short amount of time gives the Commander tremendous flexibility in finding good alternatives. Another useful way of presenting the results to the Commander is by listing the contract and manpower reduction level decisions in ascending order based on the impact/cost ratio. If the decision only involved contracts, the impact/cost ratio would essentially be used by the IP to select the optimal solution, choosing the lowest impact/cost ratio contracts until it reaches the budget constraint. Slight modifications could occur as the IP approached the budget constraint, where as higher impact/cost contracts could be included instead of lower impact/cost contracts, in order to get closer to the specified budget level, and consequently have less overall impact.

Table 4.3 shows the rank ordering of all 60 contracts and 18 organization's manpower reduction levels, including the updated dependent scores for organizations 1, 2, 16 and 17. The rank ordering is based on the impact/cost ratio discussed earlier and

provides the Commander a guide with which alternatives can be identified. Two manpower aspects prevent the Commander from taking the first x number of contracts or manpower levels from the impact/cost table. The first aspect is that Table 4.2 includes multiple manpower level selections from the same organization, even though only one can be selected per alternative. The other aspect is that the budget constraint includes more than just dollars cut—a manpower constraint must be met also.

Table 4.4 provides a look at the rank ordering of only contracts, which could be used if the Commander's decision situation changed. The cumulative impact and dollars are also provided, so the Commander can easily visualize which optimal set of contracts can be cut to reach a desired reduction goal, and what impact it has on NAIC. Before looking into how the contract and manpower reduction level impacts are affected by changes in the Commander's preferences in his value hierarchy or in what is allowed to be cut (constraints), an obvious problem can be identified by taking a quick glance at Table 4.4. Fourteen of the first fifteen contracts—those with the least impact on NAIC per dollar spent—are from organization 11. This circumstance lends itself to limiting the amount of contract dollars cut from one organization, number 11 in particular. Although the addition of this type of constraint is looked at during sensitivity analysis, the rank ordering of non-organization 11 contracts is provided in Table 4.5.

4.6 Sensitivity Analysis Results

All of the previous results are based on the assumption that the Commander is certain that the weights in his value hierarchy are exact. Although the weights represent

Table 4.3 Rank Ordering of Contract and Manpower Level Impact/Cost Ratios

Rank	Cont/Man	Impact	Dollars	People	Impact/$
1	11N	0.588	1842	0	0.00032
2	11O	0.575	1685	0	0.00034
3	14MB	0.056	130	2	0.00043
4	14MC	0.150	345	5	0.00043
5	14ME	0.296	667	10	0.00044
6	14MD	0.218	472	7	0.00046
7	11G	0.197	322	0	0.00061
8	11K	0.144	231	0	0.00062
9	13MB	0.084	130	2	0.00065
10	11F	1.204	1842	0	0.00065
11	11C	0.466	692	0	0.00067
12	11E	0.237	318	0	0.00075
13	11L	0.865	967	0	0.00089
14	13MC	0.228	234	4	0.00098
15	11A	0.778	728	0	0.00107
16	6A	0.156	133	0	0.00118
17	6MC	0.870	732	11	0.00119
18	6MB	0.367	296	5	0.00124
19	13MD	0.480	387	6	0.00124
20	11H	1.180	921	0	0.00128
21	6MD	1.500	1077	16	0.00139
22	6ME	2.190	1464	22	0.00150
23	13ME	0.797	517	8	0.00154
24	11I	0.719	461	0	0.00156
25	11M	0.969	593	0	0.00163
26	10MB	0.929	452	7	0.00205
27	11B	0.608	286	0	0.00212
28	11J	1.994	921	0	0.00216
29	4C	1.942	893	0	0.00218
30	1D	0.968	429	0	0.00226
31	3ME	2.444	987	12	0.00248
32	17MB	0.382	153	2	0.00250
33	10MC	2.196	878	14	0.00250
34	7E	2.347	891	0	0.00263
35	3MD	2.018	746	9	0.00271
36	4B	1.341	492	0	0.00273
37	11ME	3.607	1305	20	0.00276
38	1C	2.123	767	0	0.00277
39	7A	2.649	948	0	0.00279
40	10MD	3.637	1301	21	0.00280
41	17MB3	0.434	153	2	0.00283
42	18ME	2.836	985	16	0.00288
43	7MC	1.555	520	8	0.00299
44	10ME	5.017	1675	28	0.00300
45	11MC	2.001	664	10	0.00301
46	7MD	2.367	780	12	0.00303
47	3MC	1.609	528	6	0.00305
48	5MC	1.913	616	7	0.00311
49	11MD	2.998	960	15	0.00312
50	7ME	3.249	1040	16	0.00312
51	7MB	0.814	260	4	0.00313
52	5ME	3.929	1232	14	0.00319
53	5C	4.178	1288	0	0.00324
54	18MD	2.549	728	12	0.00350
55	5MD	3.178	880	10	0.00361
56	1E	0.985	266	0	0.00370
57	1B	1.373	354	0	0.00388
58	1ME	4.752	1205	15	0.00394
59	6B	2.002	507	0	0.00395
60	1A	2.216	549	0	0.00404
61	1ME14	4.908	1205	15	0.00407
62	4E	1.416	347	0	0.00408
63	5MB	1.088	264	3	0.00412
64	4A	0.949	229	0	0.00414
65	5B	1.919	462	0	0.00415
66	9ME	6.317	1512	25	0.00418
67	17MC	1.184	283	4	0.00418
68	1MD	3.748	853	11	0.00439
69	15MD	3.255	715	11	0.00455
70	17MC3	1.292	283	4	0.00457
71	1ME3	5.511	1205	15	0.00457
72	3MB	1.210	264	3	0.00458
73	1MEX2	5.564	1205	15	0.00462
74	1MD14	3.956	853	11	0.00464
75	15ME	4.322	923	15	0.00468
76	15MC	2.440	520	8	0.00469
77	18MC	2.222	468	8	0.00475
78	1MC	2.640	547	7	0.00483
79	10I	3.742	759	0	0.00493
80	9MD	5.473	1099	19	0.00498
81	11MB	1.599	319	5	0.00501
82	4ME	4.543	899	11	0.00505
83	4MC	2.443	482	6	0.00507
84	4MB	1.238	241	3	0.00513
85	1MB	1.575	306	4	0.00515
86	1MD3	4.500	853	11	0.00528
87	1MC14	2.887	547	7	0.00528
88	4MD	3.500	658	8	0.00532
89	1MDX2	4.563	853	11	0.00535
90	12ME	6.437	1192	16	0.00540
91	4D	1.364	252	0	0.00541
92	17ME	3.323	612	8	0.00543
93	16ME	3.919	720	9	0.00544
94	9MB	1.711	312	6	0.00548
95	17MD	2.517	459	6	0.00548
96	16ME3	4.080	720	9	0.00567
97	17ME3	3.480	612	8	0.00569
98	17MD3	2.657	459	6	0.00579
99	1MB14	1.773	306	4	0.00579
100	9MC	4.040	686	13	0.00589

Table 4.4 Rank Ordering of Contract Impact/Cost Ratios

Rank	Contract	Impact	Dollars	Impact/$	Cum Impact	Cum Dollars
1	11N	0.588	1842	0.00032	0.588	1842
2	11O	0.575	1685	0.00034	1.163	3527
3	11G	0.197	322	0.00061	1.361	3849
4	11K	0.144	231	0.00062	1.505	4080
5	11F	1.204	1842	0.00065	2.709	5922
6	11C	0.466	692	0.00067	3.175	6614
7	11E	0.237	318	0.00075	3.412	6932
8	11L	0.865	967	0.00089	4.277	7899
9	11A	0.778	728	0.00107	5.055	8627
10	6A	0.156	133	0.00118	5.211	8760
11	11H	1.180	921	0.00128	6.392	9681
12	11I	0.719	461	0.00156	7.111	10142
13	11M	0.969	593	0.00163	8.080	10735
14	11B	0.608	286	0.00212	8.687	11021
15	11J	1.994	921	0.00216	10.681	11942
16	4C	1.942	893	0.00218	12.623	12835
17	1D	0.968	429	0.00226	13.592	13264
18	7E	2.347	891	0.00263	15.939	14155
19	4B	1.341	492	0.00273	17.280	14647
20	1C	2.123	767	0.00277	19.403	15414
21	7A	2.649	948	0.00279	22.052	16362
22	5C	4.178	1288	0.00324	26.230	17650
23	1E	0.985	266	0.00370	27.214	17916
24	1B	1.373	354	0.00388	28.587	18270
25	6B	2.002	507	0.00395	30.589	18777
26	1A	2.216	549	0.00404	32.804	19326
27	4E	1.416	347	0.00408	34.221	19673
28	4A	0.949	229	0.00414	35.170	19902
29	5B	1.919	462	0.00415	37.088	20364
30	10I	3.742	759	0.00493	40.830	21123
31	4D	1.364	252	0.00541	42.194	21375
32	10E	3.167	527	0.00601	45.361	21902
33	5A	3.136	507	0.00618	48.497	22409
34	6C	1.580	252	0.00627	50.076	22661
35	8A	5.026	792	0.00635	55.103	23453
36	10B	4.703	720	0.00653	59.806	24173
37	10C	3.142	481	0.00653	62.948	24654
38	6D	0.488	67	0.00728	63.435	24721
39	11Q	1.734	223	0.00777	65.169	24944
40	7D	2.102	269	0.00781	67.271	25213
41	10H	1.847	231	0.00800	69.118	25444
42	11D	1.476	180	0.00820	70.594	25624
43	2G	6.358	728	0.00873	76.952	26352
44	11R	1.396	157	0.00889	78.348	26509
45	10D	3.156	282	0.01119	81.504	26791
46	1F	2.676	215	0.01244	84.179	27006
47	3A	1.648	129	0.01277	85.827	27135
48	11P	1.210	92	0.01315	87.038	27227
49	10F	1.990	133	0.01496	89.028	27360
50	2B	6.423	428	0.01501	95.451	27788
51	2F	6.214	408	0.01523	101.665	28196
52	2C	6.263	384	0.01631	107.928	28580
53	9A	6.468	354	0.01827	114.396	28934
54	10A	5.954	290	0.02053	120.350	29224
55	2H	6.387	266	0.02401	126.738	29490
56	2D	6.245	198	0.03154	132.983	29688
57	7C	3.007	89	0.03379	135.990	29777
58	2A	5.675	112	0.05067	141.666	29889
59	2E	6.318	112	0.05641	147.984	30001
60	10G	3.294	38	0.08669	151.278	30039

preferences, originate from the decision maker, and are as accurate as possible, they are subjective. While the first segment of this section is devoted to understanding the results of altering the Commander's preferences, the second segment deals with the addition of constraints which put real world limits on the contract selection process.

4.6.1 Changing Weights or Preferences

A better understanding of how the alternatives are affected by the Commander's preferences is provided by modifying the weights within the Commander's value hierarchy. It is important to note that the sensitivity analysis in this research uses a consistent form of modification. No matter which weight is chosen to be modified, the other objectives on that level maintain the same relative importance as in the Commander's original value hierarchy. For example, when the weight for Current Operations is being altered, Unit Performance is always twice (40%-20%) as important as Areas of Emphasis.

Because each of the levels underneath Current Operations (40%), Areas of Emphasis (20%) and Unit Performance (40%) have less effect than their parent objective, we initially modify and test the three main objectives listed above. The three objectives are directly below the overall objective—Minimizing the Negative Impact on NAIC—in the Commander's value hierarchy.

Table 4.5 Rank Ordering of Non-Organization 11 Contract Impact/Cost Ratios

Rank	Contract	Impact	Dollars	Impact/$	Cum Impact	Cum Dollars
1	6A	0.156	133	0.00118	0.156	133
2	4C	1.942	893	0.00218	2.099	1026
3	1D	0.968	429	0.00226	3.067	1455
4	7E	2.347	891	0.00263	5.414	2346
5	4B	1.341	492	0.00273	6.755	2838
6	1C	2.123	767	0.00277	8.878	3605
7	7A	2.649	948	0.00279	11.527	4553
8	5C	4.178	1288	0.00324	15.705	5841
9	1E	0.985	266	0.00370	16.690	6107
10	1B	1.373	354	0.00388	18.063	6461
11	6B	2.002	507	0.00395	20.064	6968
12	1A	2.216	549	0.00404	22.280	7517
13	4E	1.416	347	0.00408	23.696	7864
14	4A	0.949	229	0.00414	24.645	8093
15	5B	1.919	462	0.00415	26.564	8555
16	10I	3.742	759	0.00493	30.306	9314
17	4D	1.364	252	0.00541	31.669	9566
18	10E	3.167	527	0.00601	34.836	10093
19	5A	3.136	507	0.00618	37.972	10600
20	6C	1.580	252	0.00627	39.552	10852
21	8A	5.026	792	0.00635	44.578	11644
22	10B	4.703	720	0.00653	49.281	12364
23	10C	3.142	481	0.00653	52.423	12845
24	6D	0.488	67	0.00728	52.911	12912
25	7D	2.102	269	0.00781	55.012	13181
26	10H	1.847	231	0.00800	56.859	13412
27	2G	6.358	728	0.00873	63.217	14140
28	10D	3.156	282	0.01119	66.373	14422
29	1F	2.676	215	0.01244	69.049	14637
30	3A	1.648	129	0.01277	70.697	14766
31	10F	1.990	133	0.01496	72.687	14899
32	2B	6.423	428	0.01501	79.110	15327
33	2F	6.214	408	0.01523	85.324	15735
34	2C	6.263	384	0.01631	91.587	16119
35	9A	6.468	354	0.01827	98.055	16473
36	10A	5.954	290	0.02053	104.009	16763
37	2H	6.387	266	0.02401	110.397	17029
38	2D	6.245	198	0.03154	116.642	17227
39	7C	3.007	89	0.03379	119.649	17316
40	2A	5.675	112	0.05067	125.325	17428
41	2E	6.318	112	0.05641	131.643	17540
42	10G	3.294	38	0.08669	134.937	17578

Before accomplishing the sensitivity analysis, a couple of details must be noted. The first issue is an assumption that the Commander's preferences will not vary drastically. For this reason, the modification of weights for each case is plus or minus

20%. The next issue clarifies why there may be *holes* in the sensitivity analysis. Because each scenario utilizes an integer program to find the optimal solution, an alternative may be optimal for scenarios A and C, but not for scenario B. For example, an alternative may be optimal when the Current Operations weight is 30% and 40%, but not when it is 35%. This is a natural result of the knapsack problem, where a small difference could cause a change in the optimal alternative.

The first sensitivity analysis deals with modifying the weight of Current Operations between 20% and 60%, at 5% intervals. For brevity purposes, Table 4.6 lists only non-persistent components--those contracts which are cut and manpower reduction levels that were chosen in at least one, but not all nine scenarios. Contracts 11N and 11O were persistent, as well as 0% manpower reduction levels for organizations 1, 2, 3, 4, 5,

Table 4.6 Sensitivity of Changing Current Operations' Weight

CO	.20	.25	.30	.35	**.40**	.45	.50	.55	.60	
AoE	.27	.25	.23	.22	**.20**	.18	.17	.15	.13	
UP	.53	.50	.47	.43	**.40**	.37	.33	.30	.27	
6A									Y	1
11C	Y	Y								2
11E	Y	Y								2
11F			Y	Y	Y	Y	Y	Y	Y	7
11K			Y	Y	Y	Y	Y	Y		6
11L	Y	Y								2
6MD	Y	Y								2
6ME			Y	Y	Y	Y	Y	Y	Y	7
10MA	Y	Y								2
10MB			Y	Y	Y	Y	Y	Y	Y	7
11MA			Y	Y	Y	Y	Y	Y	Y	7
11ME	Y	Y								2
13MC	Y	Y								2
13ME			Y	Y	Y	Y	Y	Y	Y	7
17MA	Y	Y								2
17MB			Y	Y	Y	Y	Y	Y	Y	7
Totals	23	23	22	22	22	22	22	22	22	
Impact	5.774	6.422	6.865	6.985	7.105	7.225	7.345	7.465	7.583	
Dollars	8787	8787	8853	8853	8853	8853	8853	8853	8755	
Personnel	50	50	49	49	49	49	49	49	49	

7, 8, 9, 12, 15, 16, and 18 and 20% reduction level for organization 14. For contracts, the letter 'Y' designates that yes, the contract is selected to be cut. For manpower, it states that the identified reduction level for that organization is selected as part of the optimal alternative. The fifteen persistent elements listed above were oblivious to the changing of Current Operation's weight, while seven others (contracts 11F and 11K, 0% manpower reduction level cuts for organization 11, 5% cuts for organizations 10 and 17, and 20% cuts for organizations 6 and 13) were strongly persistent--not affected until the weight dipped to 25%. This is evidence of a fairly robust solution because there is very low likelihood the Commander would weight Current Operations lower than 30%. Analysis of the initial model's sensitivity to the other two objectives is listed below in Tables 4.7 and 4.8.

Table 4.7 Sensitivity of Changing Areas of Emphasis' Weight

CO	.50	.48	.45	.43	**.40**	.38	.35	.33	.30	
AoE	.00	.05	.10	.15	**.20**	.25	.30	.35	.40	
UP	.50	.48	.45	.43	**.40**	.38	.35	.33	.30	
6A	Y	Y	Y							3
11C							Y	Y	Y	3
11E							Y	Y	Y	3
11F	Y	Y	Y	Y	Y	Y				6
11K				Y	Y	Y				3
11L							Y	Y	Y	3
7MA			Y	Y	Y	Y	Y	Y	Y	7
7MB	Y	Y								2
13MD	Y	Y								2
13ME			Y	Y	Y	Y	Y	Y	Y	7
17MA	Y	Y								2
17MB			Y	Y	Y	Y	Y	Y	Y	7
Totals	22	22	22	22	22	22	23	23	23	
Impact	7	7	7	7	7	7	7	7	7	
Dollars	8732	8732	8755	8853	8853	8853	8757	8757	8757	
Personnel	49	49	49	49	49	49	49	49	49	

The persistent contracts and manpower reduction levels when changing the weight of Areas of Emphasis included contracts 11N and 11O, a 0% reduction level for organizations 1, 2, 3, 4, 5, 8, 9, 11, 12, 15, 16, and 18, a 5% reduction level for organization 10 and a 20% reduction level for organizations 6 and 14. Manpower reduction levels of 0%, 5% and 20% for organizations 7, 17 and 13, respectively, showed strong persistence as long as the Commander's Areas of Emphasis weight remained between 10% and 40%. Contract 11F was also fairly persistent, as long as the Areas of Emphasis weight did not exceed 25%.

Table 4.8 Sensitivity of Changing Unit Performance's Weight

CO	.53	.50	.47	.43	**.40**	.37	.33	.30	.27	
AoE	.27	.25	.23	.22	**.20**	.18	.17	.15	.13	
UP	.20	.25	.30	.35	**.40**	.45	.50	.55	.60	
6MD								Y	Y	2
6ME	Y	Y	Y	Y	Y	Y	Y			7
7MA	Y	Y	Y	Y	Y	Y		Y	Y	8
7MB							Y			1
10MA								Y	Y	2
10MB	Y	Y	Y	Y	Y	Y	Y			7
11MA	Y	Y	Y	Y	Y	Y	Y			7
11ME								Y	Y	2
13MC								Y	Y	2
13MD							Y			1
13ME	Y	Y	Y	Y	Y	Y				6
17MA							Y	Y	Y	3
17MB	Y	Y	Y	Y	Y	Y				6
Totals	22	22	22	22	22	22	22	22	22	
Impact	7	7	7	7	7	7	7	7	6	
Dollars	8853	8853	8853	8853	8853	8853	8830	8883	8883	
Personnel	49	49	49	49	49	49	49	50	50	

Changing the weight of Unit Performance, like Current Operations, also produced a very robust solution. Contracts 11F, 11K, 11N and 11O were unaffected by Unit Performance weight changes, as were the 0% manpower reduction levels of organization

1, 2, 3, 4, 5, 8, 9, 12, 15, 16, and 18 and the 20% manpower reduction level of organization 14.

Like the initial scenario, a useful way to present the results of the sensitivity analysis is through the use of impact/cost ratio tables. By modifying the weights of the three objectives, the Commander can visualize the changes that occurred in the impact/cost ratios. Each of the three objectives were modified by plus and minus 10% and are presented in each of the three types of tables. For example, the original weight for Current Operations was moved from 40% to both 30% and 50%. The three types of impact/cost ratio tables that are presented in the Appendices are presented in the same format as in the initial results: Appendix F—Rank Ordering of Contract and Manpower Level Impact/Cost Ratios, G—Rank Ordering of Contract Impact/Cost Ratios and H—Rank Ordering of Non-Organization 11 Contract Impact/Cost Ratios. Appendix F presents the Impact/Cost rank ordering of all elements, both contracts and manpower levels. Appendix G presents the rank ordering of only the 60 contracts, while Appendix H rank orders the 42 contracts from organizations 1-10.

4.6.2 Constraint Additions

As stated earlier in Section 4.5, the original optimal solution included four contracts, all of which were from organization 11. This is an obvious place to begin constraining the IP. Discussions with NAIC concluded that limitations should be placed on the amount of money cut from organization 11. The constraint limiting the amount of money cut from organization 11 was 5% of its total contract value, or $623 thousand.

This value, however, is not considered an upper or lower bound. Instead, it is an approximate goal. Therefore, the model was programmed to find a solution that reduced the amount of organization 11's contract dollars between $500 and $750 thousand. Determined by NAIC, this range forces the optimal alternative to include between approximately 4% and 6% of organization 11's money to be cut. The two added constraints in the IP were 1) the sum of the contracts cut from organization 11 ≥ $500 thousand, and 2) the sum of the contracts cut from organization 11 ≤ $750 thousand. They were modeled by summing the products of the contract dollar amounts and the binary decision variables associated with that contract.

With this added constraint, the optimal solution, using the Commander's original weights, produced an alternative with a total impact of 16.961. This alternative cut $8.718 million and 61 personnel positions, but more than doubles the amount of negative impact on NAIC, relative to the initial alternative. The results, including sensitivity analysis based on changing the main objective weights, is shown in Table 4.9.

The completely persistent elements of this problem were contracts 4C and 6A, 0% manpower reduction levels for organizations 4, 5, 8, 9, 12, and 15, and 20% manpower reduction levels for organizations 6 and 14. Although not obvious, the 0% manpower reduction levels for organizations 1, 2 and 16 are all completely persistent. This is because the 20% manpower reductions for organizations 3 and 14 occasionally forced the use of the dependent scores. No matter which set of scores were used, the 0% manpower reduction levels for organizations 1, 2 and 16 were selected. If the assumption that 0% dependent manpower scores have no impact is violated, these results could change.

Table 4.9 "5% of Organization 11" Constrained Problem with Sensitivity Analysis

	Changing Current Operations					Changing Areas of Emphasis					Changing Unit Performance					
CO	.20	.30	**.40**	.50	.60	.50	.45	**.40**	.35	.30	.53	.47	**.40**	.33	.27	
AoE	.27	.23	**.20**	.17	.13	.00	.10	**.20**	.30	.40	.27	.23	**.20**	.17	.13	
UP	.53	.47	**.40**	.33	.27	.50	.45	**.40**	.35	.30	.20	.30	.40	.50	.60	Total
1C	Y	Y							Y						Y	4
1D	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y		Y	Y	Y	Y	14
1E	Y									Y						2
4A															Y	1
4B	Y	Y	Y	Y		Y	Y	Y					Y	Y	Y	10
7A			Y	Y	Y	Y	Y	Y			Y	Y	Y			9
7E			Y	Y	Y	Y	Y	Y			Y		Y	Y		9
11C			Y	Y	Y	Y	Y	Y	Y		Y	Y	Y		Y	11
11E	Y	Y								Y				Y		4
11G	Y	Y								Y				Y		4
1MA14				Y	Y						Y					3
1MAX2	Y	Y	Y			Y	Y	Y	Y	Y		Y	Y	Y	Y	12
2MA14				Y	Y						Y					3
2MAX2	Y	Y	Y			Y	Y	Y	Y	Y		Y	Y	Y	Y	12
3MA				Y	Y						Y					3
3ME	Y	Y	Y			Y	Y	Y	Y	Y		Y	Y	Y	Y	12
7MA	Y	Y	Y	Y		Y	Y	Y	Y	Y		Y	Y	Y	Y	13
7MC					Y						Y					2
10MB	Y	Y	Y	Y	Y	Y	Y	Y		Y			Y	Y	Y	12
10MC									Y		Y	Y				3
11MA			Y	Y	Y	Y	Y	Y			Y	Y	Y			9
11ME	Y	Y							Y	Y				Y	Y	6
13MC	Y														Y	2
13MD														Y		1
13ME		Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y			12
16MA				Y	Y						Y					3
16MA3	Y	Y	Y			Y	Y	Y	Y	Y		Y	Y	Y	Y	12
17MA3	Y	Y							Y	Y				Y	Y	6
17MB				Y	Y						Y					3
17MB3			Y			Y	Y	Y				Y	Y			6
18MA	Y	Y	Y			Y	Y	Y	Y				Y	Y	Y	10
18ME				Y	Y					Y	Y	Y				5
Totals	26	25	25	25	24	25	25	25	23	24	23	23	25	25	25	
Impact	13.08	15.25	16.96	17.53	17.68	16.47	16.72	16.96	16.62	15.87	17.54	17.46	16.96	15.52	13.76	
Dollars	8729	8746	8718	8716	8744	8718	8718	8718	8732	8738	8741	8746	8718	8740	8744	
Personnel	75	79	61	65	73	61	61	61	86	95	80	84	61	77	75	

In addition to these, many other elements were strongly persistent over the ranges of sensitivity analysis. As can be seen in Table 4.9, contract 1D, 0% manpower reduction level for organization 7, 5% manpower reduction level for organization 10, and 20% manpower reduction levels for organizations 3 and 13 are fairly insensitive to the changes in weights. Combined with the completely persistent elements, these provide the

Commander with a broad group of possibilities from which to cut.

Taking the decision maker's guidance one step further, additional sensitivity analysis was performed on variations of the amount of money cut from organization 11. Appendices I and J display the results of "less than $3 million cut from organization 11" and "less than $2 million cut from organization 11" constrained models. Not allowing any contracts from organization 11 to be cut is presented in Appendix K.

Using the decision maker's "5%" constraint, sensitivity analysis can be performed on the possible change in the $8.716 million constraint. This type of analysis allows the Commander to see if changing his cut requirement causes drastic changes in the optimal solution. Table 4.10 shows the results of varying the dollar constraint between $8.116 and $9.316 million at $0.3 million intervals.

Table 4.10 Changing Dollar Constraint Sensitivity Analysis

	> 8.116	> 8.416	**> 8.716**	> 9.016	> 9.316	
1C					Y	1
4B	Y		Y	Y	Y	4
7A			Y		Y	2
11C	Y	Y	Y		Y	4
11E				Y		1
11G				Y		1
7MA		Y	Y	Y	Y	4
7MC	Y					1
11MA	Y		Y		Y	3
11ME		Y		Y		2
17MA3	Y	Y			Y	3
17MB3			Y	Y		2
Totals	24	23	25	25	26	
Impact	15.433	16.144	16.961	17.887	18.650	
Dollars	8137	8430	8718	9023	9332	
Personnel	67	79	61	81	59	

No matter how much the budget constraint varied within the $1.2 million range, the following elements were completely persistent: contracts 1D, 4C, 6A, and 7E, 0%

manpower reduction levels for organizations 1, 2, 4, 5, 8, 9, 12, 15, 16 and 18, 5% manpower reduction level for organization 10, and 20% manpower reduction levels for organizations 3, 6, 13, and 14.

With the exception of the 0% manpower reduction level for organization 7, which is fairly persistent, each of the elements shown in Table 4.10 have holes somewhere along the dollar range. This is a direct result of the IP knapsack problem. Even though they are not persistent, selecting any one of these reductions, by virtue that they were selected in at least one of the optimal alternatives, would not be considered a poor decision.

The last set of sensitivity analysis deals with adding a constraint that originates from the actual scoring sheets. Three of the attributes ask the organization leaders to score how the contract or manpower reductions would affect NAIC's ability to fulfill DoDIPP requirements for the Acquisition, Operational and Policymaker Communities. The scores range between zero (No Impact) and 10 (Lane Lost). When given an option, NAIC prefers not to lose an entire lane, and instead retains all of its capabilities at reduced levels. Because of this, sensitivity analysis was performed using the constraints listed below, in addition to the constraint that no lanes are allowed to be lost. The set of contracts and manpower reduction levels that cause at least 90% of a lane lost are not allowed to be selected by the IP. This set includes contracts 2A, 2B, 2C, 2D, 2E, 2F, 2G, 2H, 8A, and 9A; 5%, 10%, 15% and 20% manpower reduction levels for organization 2; 15% and 20% reduction levels for organizations 5 and 11; and 20% reduction levels for organizations 6, 9 and 12. By not allowing cuts that would cause a lane loss, the IP could find a different alternative. Six different optimal solutions are presented in Table 4.11,

one for each of the following constraints: A—Unconstrained, B—Organization 11 cut no more than $3M, C—Organization 11 cut no more than $2M, D—Organization 11 cut between $0.50M and $0.75M, E—Organization 11 not cut, and F—No $1M contracts cut and no more than 4-organization 11 contracts cut.

No contract cuts were persistent across the six different models; however, contracts 1D, 4C and 6A were persistent across the five that had contract-limiting constraints. The 0% reduction level for organizations 4, 5, 8, 9, 11, 12, and 15, as well as the 20% reduction levels for organizations 13 and 14 were completely persistent. Interestingly, the 15% manpower reduction level for organization 6 was persistent for each of the six models. Prior to its elimination from being in the potential feasible alternatives, the 20% reduction level for organization 6 had been a persistent selection throughout most of the sensitivity analysis. Even though the 20% manpower level for organization 6 was eliminated, the low impact caused by cutting people in organization 6 still found a way into the alternatives by taking the highest cut (15%) that does not cause lanes to be lost. This is the only major change that occurred due to the withdrawal of lane-losing elements.

4.7 Conclusions

The sensitivity analysis performed in Chapter IV is designed to aid the Commander in making a better decision. In fact, any additional constraints or changes in the preferences can easily be incorporated into the model. Using Microsoft Excel for

Table 4.11 Optimal Solutions for Lanes Lost Analysis with Different Constraints

	A	B	C	D	E	F	
1C			1		1		2
1D		1	1	1	1	1	5
4B		1		1	1		3
4C		1	1	1	1	1	5
6A		1	1	1	1	1	5
7E			1	1	1		3
11A						1	1
11C		1		1		1	3
11F	1						1
11G		1					1
11H						1	1
11K	1	1	1				3
11L						1	1
11N	1						1
11O	1	1	1				3
1MA14	1						1
1MAX2		1	1	1	1	1	5
2MA14	1						1
2MAX2		1	1	1	1	1	5
3MA	1						1
3ME		1	1	1	1	1	5
7MA		1	1		1		3
7MB						1	1
7MC	1			1			2
10MB	1	1	1	1		1	5
10MC					1		1
16MA	1						1
16MA3		1	1	1	1	1	5
17MA	1						1
17MA3			1		1	1	3
17MB3		1		1			2
18MA	1	1	1	1		1	5
18ME					1		1
Totals	22	26	25	25	24	25	
Impact	7.588	12.191	14.223	17.508	18.948	13.137	
Dollars	8833	8730	8729	8721	8716	8723	
Personnel	49	55	53	61	76	57	

A--No Limiting Constraints
B--Organization 11 Contracts Cuts Less than $3M
C--Organization 11 Contracts Cuts Less than $2M
D--Organization 11 Contracts Cut about $0.62M
E--Organization 11 Contracts not cut
F--At most 4-organization 11 Contracts cut; No $1M Cut

Windows 95, version 7.0, on a 166 Mhz personal computer, the run times varied anywhere between 15 seconds and 25 minutes, depending on the set of constraints used. Based on the fact that there are many different influences that the Commander has to deal with, the flexibility sensitivity analysis offers can be used to identify the best alternative for NAIC.

V. Conclusions and Recommendations

5.1 Conclusions

The objectives of this research were to develop a methodology that would save time and insert objectivity into the process of submitting budget reduction proposals for both the current and future program submission cycles. This research concludes that decision analysis using value-focused thinking can be a very effective approach to making multiple-resource, allocation decisions. Additionally, this research takes significant steps into finding ways of evaluating numerous portfolio alternatives using a standard spreadsheet.

Because of the change in command at NAIC, modifications to the former Commander's value hierarchy were required. Although many objectives were similar, a total re-evaluation had to be accomplished in order to accurately measure the current Commander's values and preferences. After updating the values in the *old* value tree to represent the changes in the organization over the past year, the "straw-man" hierarchy was used to help guide the Commander through the value identification process in a timely manner. Having the previous Commander's value hierarchy certainly made the value assessment process run smoothly.

This research shows the value of using decision analysis to deal with multiple resource allocation. Not only can the value-hierarchy be utilized for quantifying both dollar and personnel reductions, it does this without requiring significant modifications to the scoring sheets. This enabled the organizational leaders to easily understand the

relationship between the two resources. None of these aspects, however, would have meant much had the dependency issues not been resolved.

Without initially assuming independence, the optimal alternative would have essentially been computationally impossible to determine. By assuming independence, the contracts and manpower reduction levels were allowed to be evaluated separately and brought together with the total impact equaling the sum of the parts. After identifying which manpower reduction levels were the most likely to be included in the optimal solutions (and associated sensitivity analysis), the dependencies had to be determined so each dependent contract and manpower reduction level could be re-scored. Once all of the dependencies were determined, the problem could be modeled using new variables and newly constructed constraints—providing a more complete look at the decision situation. As long as there were not significantly different impacts due to interdependencies, the assumption of independence would have provided a very good solution, had we stopped there.

In addition to the improvements in time management and subjectivity, this process—specifically the value-focused thinking portion—enabled the people at NAIC to understand the Commander's values. This benefit should not be underestimated.

The most important conclusion is that this methodology is incredibly flexible. The fact that it only takes a few minutes to arrive at a new alternative once the addition or modification of constraints is known, can be extremely beneficial. Never before could the NAIC Commander consider, evaluate, and then modify numerous alternatives without

expending a huge amount of his time and effort, as well as that of his supporting leaders and staff.

Lastly, this research helped the Commander reduce the amount of negative impact caused by the reduction in resources. From the initial model, the lower bound was found to be 7.105. Although adding the constraint that forces NAIC to take between 4% and 6% from organization 11, more than doubled the total negative impact on NAIC to 16.961, this alternative is the absolute best. No feasible alternative for this model can have less negative impact on NAIC.

5.2 Recommendations

Assuming that biases are not overly inflating or deflating scores, I would recommend looking at organization 11 to see why its impacts scored relatively low, two years in a row. Although it consistently scores on the lower end of the impact/cost ratio tables, it is where NAIC spends most of its money. This leads to the next recommendation, which is having some form of check and balance system. Without this type of system, nobody can ever be sure how biases affect the scoring, and consequently, the optimal alternatives.

Two possible solutions that could help alleviate this problem are as follows. First, the scoring could be done at a higher level and by fewer people. This would certainly result in a higher degree of consistency, but it would be at the expense of a more thorough knowledge of the organizational intricacies and how they truly impact NAIC as a whole. The second solution method for scoring more accurately is bringing everyone together, so

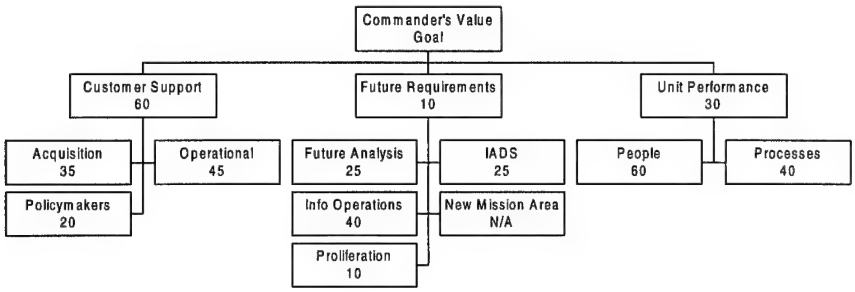
that nobody can artificially raise the impact of their resources without getting put on the spot. This would allow other leaders to see how other resources score, and would therefore result in more consistent and less-biased scoring.

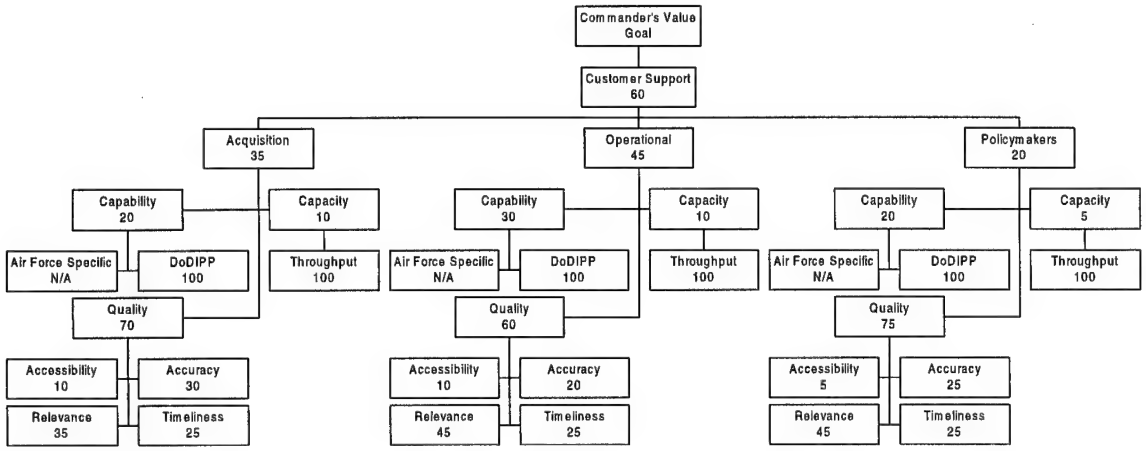
The next overall recommendation is to take a serious look at the personnel evaluated—for the most part, the impact of cutting personnel was lower than cutting contracts. This was seen in the fact that the optimal solutions often identified more than 49 personnel positions to be cut.

Rather than limiting the problem to simply reductions in resources, future research could look into how additions of resources could be added into the equation. Another possible topic could be looking at where an organization wants to allocate their resources for longer time periods—i.e. five or ten years down the road. Lastly, further research could look at the possibilities of different futures and which resource allocation alternative would be the best choice, given probabilities of different futures.

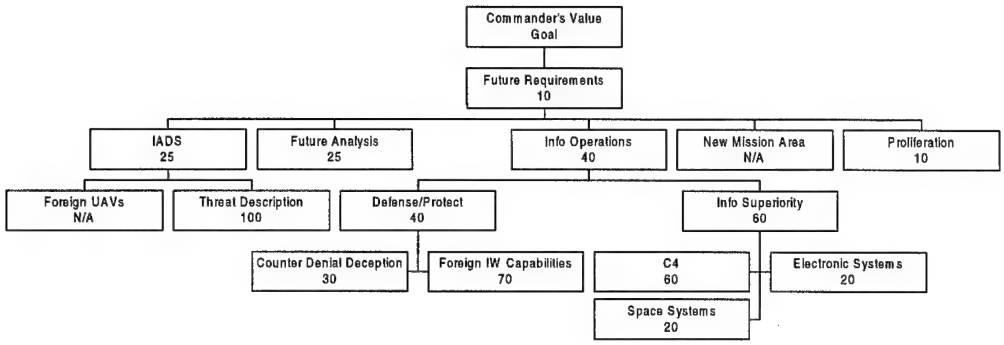
As far as maintaining this research as a tool for future use by NAIC, the value hierarchy should be updated on a regular basis. The number of contracts and the dollar amounts would change from year to year, as would the actual scoring of the contracts and manpower reduction levels. With these modifications, this tool would still be applicable and certainly beneficial to NAIC in the future.

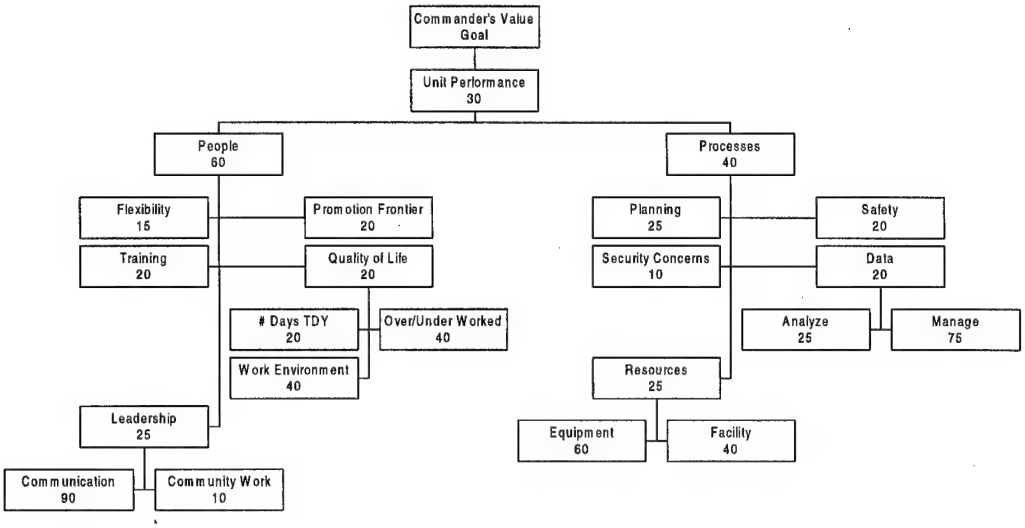
Appendix A. Previous NAIC Commander's Value Hierarchy



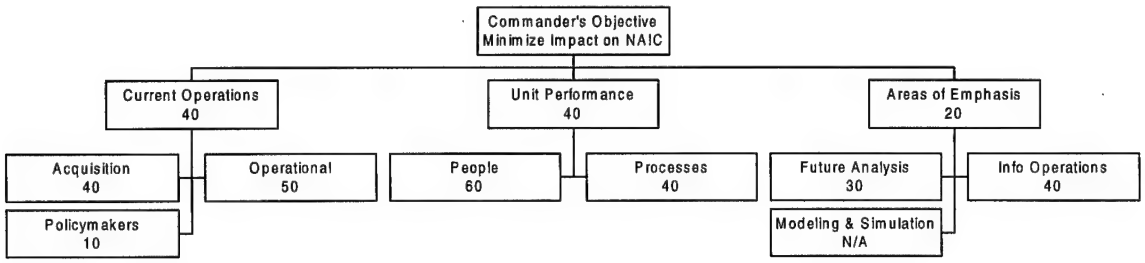


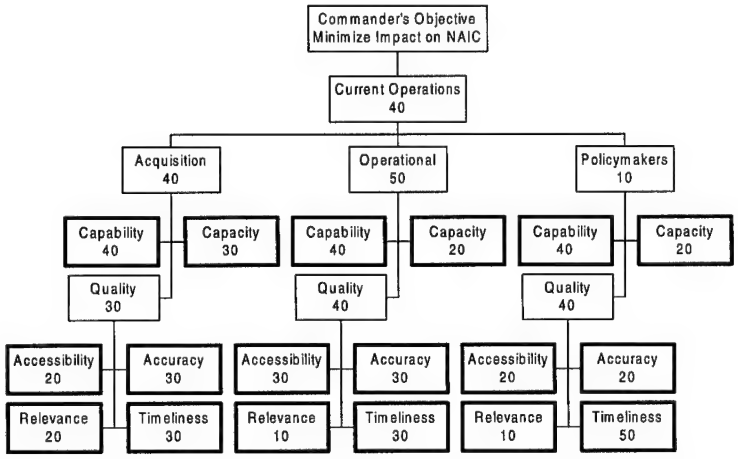
Appendix A. Previous NAIC Commander's Value Hierarchy



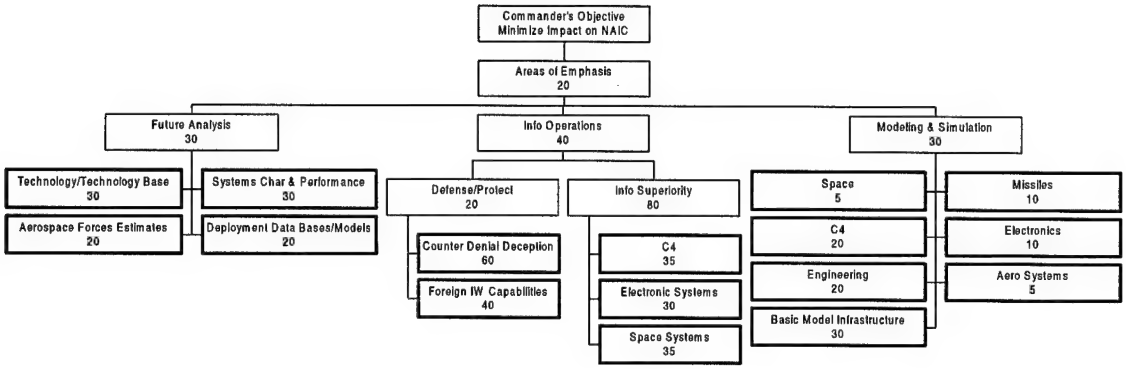


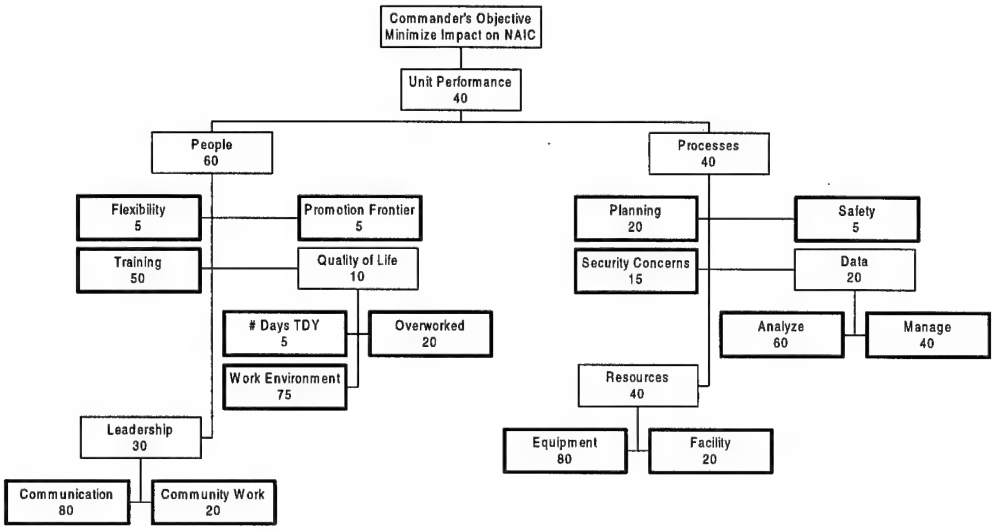
Appendix B. NAIC Commander's Value Hierarchy





Appendix B. NAIC Commander's Value Hierarchy



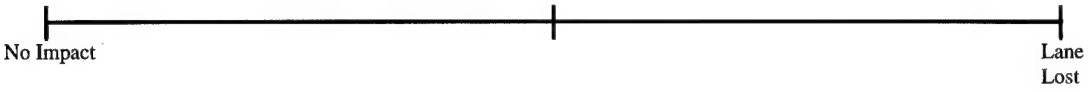


Appendix C. Scoring Sheets

CURRENT OPERATIONS

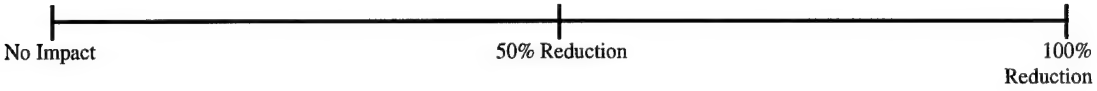
Acquisition: Capability

If this contract is cut, how will it affect NAIC's ability to fulfill DoDIPP requirements for the Acquisition Community?



Acquisition: Capacity

If this contract is cut, how will it reduce NAIC's ability to satisfy Acquisition customer requirements? In other words, will your organization still have the ability to satisfy, fulfill and accommodate Acquisition customer requirements that are placed on your organization?

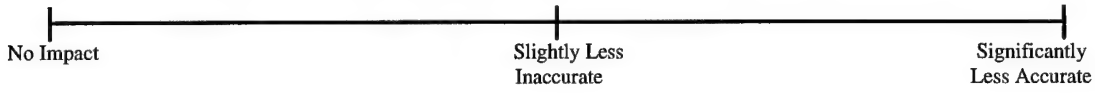


Acquisition: Quality: Accessibility

If this contract is cut, how will it affect NAIC's ability to provide an accessible product to the Acquisition Community? Inaccessible can be defined in terms of the medium, such as CD-ROM, Network linkups, etc., or classification level.

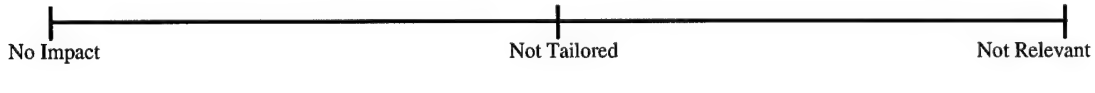
Acquisition: Quality: Accuracy

If this contract is cut, how will it affect the accuracy of products provided to the Acquisition Community? With accuracy, think in terms of the information provided. Will the information provided be any less accurate because of this cut?



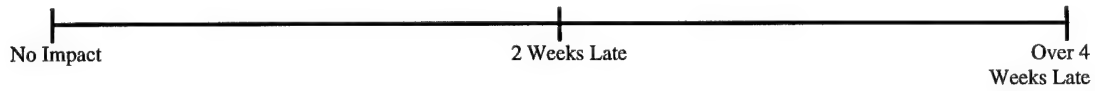
Acquisition: Quality: Relevance

If this contract is cut, how will it impact the ability to provide a relevant and tailored product to the Acquisition Community?



Acquisition: Quality: Timeliness

If this contract is cut, how will it impact the ability to provide an on-time product to the Acquisition Community? Do not mark this scale on how late your products are now, but on how much later your products will become if this contract is cut.

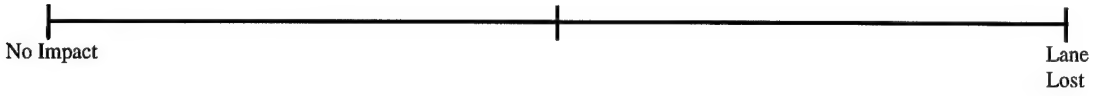


Appendix C. Scoring Sheets

CURRENT OPERATIONS

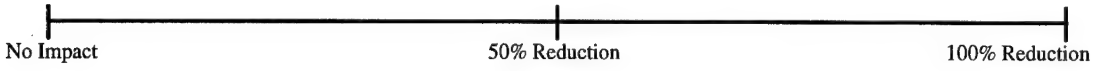
Operational: Capability

If this contract is cut, how will it affect NAIC's ability to fulfill DoDIPP requirements for the Operational Community?



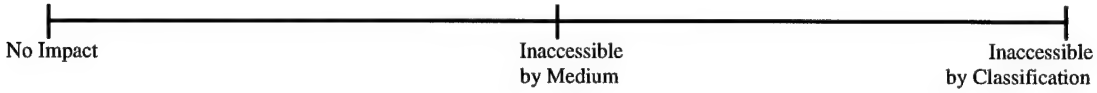
Operational: Capacity

If this contract is cut, how will it reduce NAIC's ability to satisfy Operational customer requirements? In other words, will your organization still have the ability to satisfy, fulfill and accommodate Operational customer requirements that are placed on your organization?



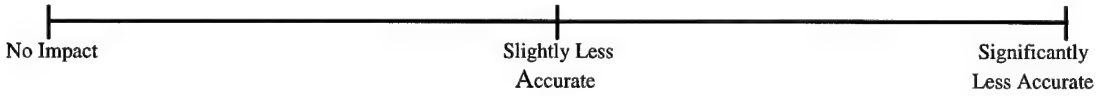
Operational: Quality: Accessibility

If this contract is cut, how will it affect NAIC's ability to provide an accessible product to the Operational Community? Inaccessible can be defined in terms of the medium, such as CD-ROM, Network linkups, etc., or classification level.



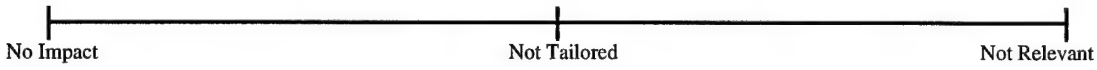
Operational: Quality: Accuracy

If this contract is cut, how will it affect the accuracy of products provided to the Operational Community? With accuracy, think in terms of the information provided. Will the information provided be any less accurate because of this cut?



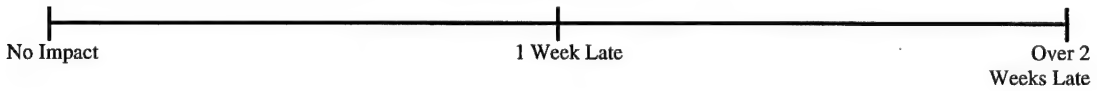
Operational: Quality: Relevance

If this contract is cut, how will it impact the ability to provide a relevant and tailored product to the Operational Community?



Operational: Quality: Timeliness

If this contract is cut, how will it impact the ability to provide an on-time product to the Operational Community? Do not mark this scale on how late your products are now, but on how much later your products will become if this contract is cut.

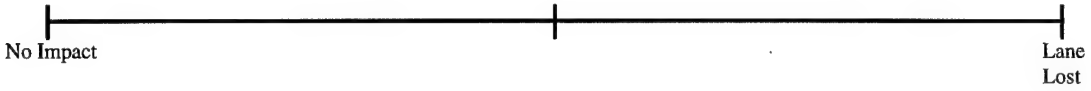


Appendix C. Scoring Sheets

CURRENT OPERATIONS

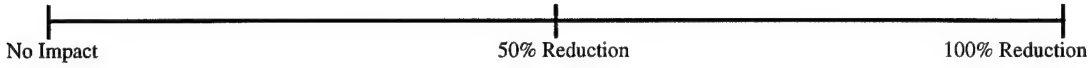
Policymakers: Capability

If this contract is cut, how will it affect NAIC's ability to fulfill DoDIPP requirements for the Policymakers Community?



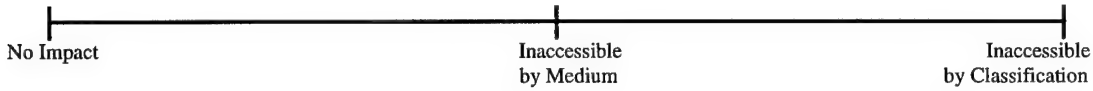
Policymakers: Capacity

If this contract is cut, how will it reduce NAIC's ability to satisfy Policymakers customer requirements? In other words, will your organization still have the ability to satisfy, fulfill and accommodate Policymakers customer requirements that are placed on your organization?



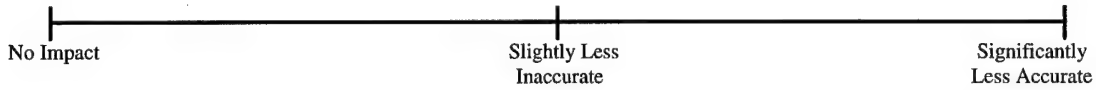
Policymakers: Quality: Accessibility

If this contract is cut, how will it affect NAIC's ability to provide an accessible product to the Policymakers Community? Inaccessible can be defined in terms of the medium, such as CD-ROM, Network linkups, etc., or classification level.



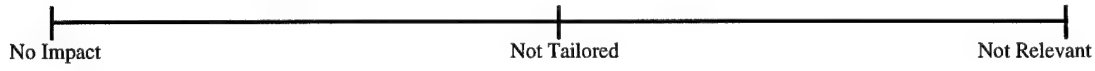
Policymakers: Quality: Accuracy

If this contract is cut, how will it affect the accuracy of products provided to the Policymakers Community? With accuracy, think in terms of the information provided. Will the information provided be any less accurate because of this cut?



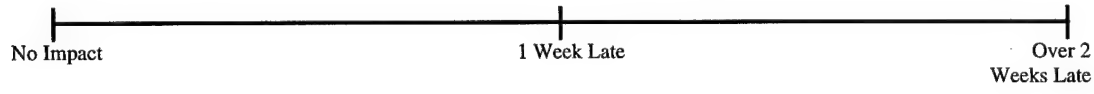
Policymakers: Quality: Relevance

If this contract is cut, how will it impact the ability to provide a relevant and tailored product to the Policymakers Community?



Policymakers: Quality: Timeliness

If this contract is cut, how will it impact the ability to provide an on-time product to the Policymakers Community? Do not mark this scale on how late your products are now, but on how much later your products will become if this contract is cut.

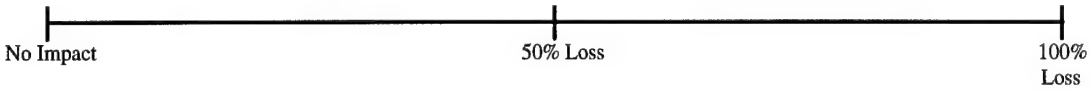


Appendix C. Scoring Sheets

AREAS OF EMPHASIS

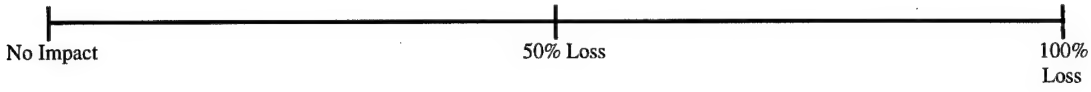
Future Analysis: Technology/Technology Base

If this contract is cut, how will it affect NAIC's ability to perform future analysis associated with technology and technology base of foreign countries? At the 100% level, all ability to perform the future analysis on technology and technology base is lost.



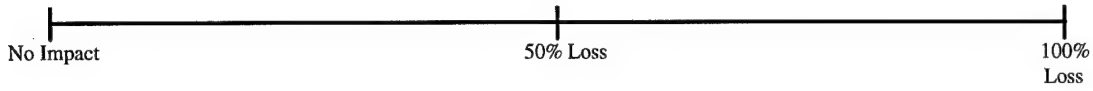
Future Analysis: Systems Characteristics and Performance

If this contract is cut, how will it affect NAIC's ability to perform future analysis associated with systems characteristics and performance of foreign countries? At the 100% level, all ability to perform the future analysis on systems characteristics and performance is lost.



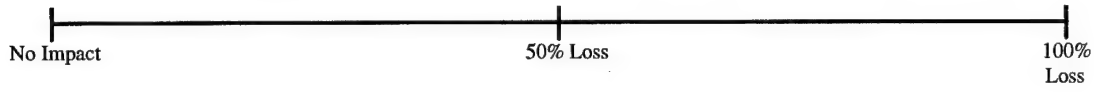
Future Analysis: Aerospace Forces Estimates

If this contract is cut, how will it affect NAIC's ability to perform future analysis on aerospace forces estimates? At the 100% level, all ability to perform the future analysis on aerospace forces estimates is lost.



Future Analysis: Deployment Data Bases and Models

If this contract is cut, how will it affect NAIC's ability to perform future analysis associated with deployment data bases and models? At the 100% level, all ability to perform the future analysis on deployment data bases and models is lost.

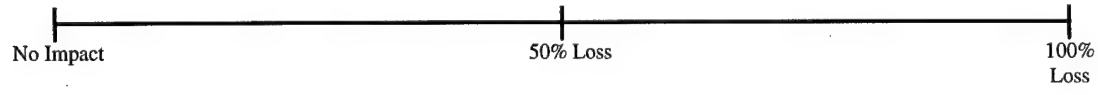


Information Operations: Defense/Protect: Counter Denial/Deception

If this contract is cut, how will it affect NAIC's ability to perform analysis on counter denial/deception?

Information Operations: Defense/Protect: Foreign IW Capabilities

If this contract is cut, how will it affect NAIC's ability to produce intelligence about foreign countries' capabilities or intentions to conduct information warfare?

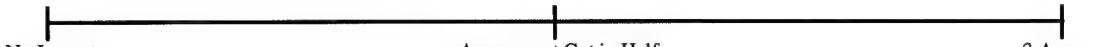


Appendix C. Scoring Sheets

AREAS OF EMPHASIS

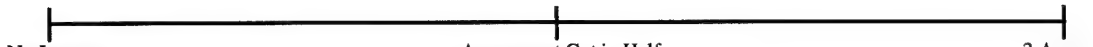
Information Operations: Information Superiority: C4

If this contract is cut, how will it affect NAIC's ability to assess or produce foreign countries' capabilities and intentions associated with command, control, communications, and computers? Base your response on three areas: (1) Systematically examining all possible explanations for events, (2) understanding the assumptions that are critical to the assessment, and (3) identifying the types of new information or changes in events that would cause us to change the assessment?



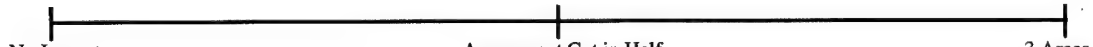
Information Operations: Information Superiority: Electronic Systems

If this contract is cut, how will it affect NAIC's ability to assess or produce foreign countries' capabilities and intentions associated electronic systems? Base your response on three areas: (1) Systematically examining all possible explanations for events, (2) understanding the assumptions that are critical to the assessment, and (3) identifying the types of new information or changes in events that would cause us to change the assessment?



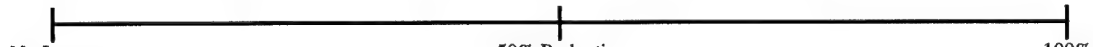
Information Operations: Information Superiority: Space Systems

If this contract is cut, how will it affect NAIC's ability to assess or produce foreign countries' capabilities and intentions associated space systems? Base your response on three areas: (1) Systematically examining all possible explanations for events, (2) understanding the assumptions that are critical to the assessment, and (3) identifying the types of new information or changes in events that would cause us to change the assessment?



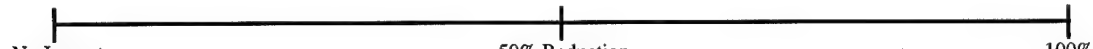
Modeling and Simulation: Space

If this contract is cut, how will it affect NAIC's ability to model and simulate foreign space systems? At the 100% level, all ability to model and simulate space systems is lost.



Modeling and Simulation: Missiles

If this contract is cut, how will it affect NAIC's ability to model and simulate foreign missile systems? At the 100% level, all ability to model and simulate missiles is lost.

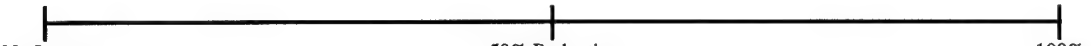


Appendix C. Scoring Sheets

AREAS OF EMPHASIS

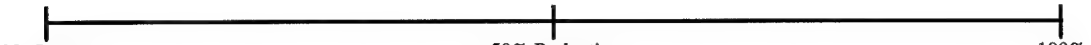
Modeling and Simulation: C4

If this contract is cut, how will it affect NAIC's ability to model and simulate C4? At the 100% level, all ability to model and simulate command, control, communications and computers is lost.



Modeling and Simulation: Electronics

If this contract is cut, how will it affect NAIC's ability to model and simulate electronic systems? At the 100% level, all ability to model and simulate electronic systems is lost.

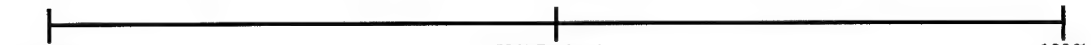


Modeling and Simulation: Engineering

If this contract is cut, how will it affect NAIC's ability to model and simulate reengineering of production processes? At the 100% level, all ability to model and simulate the reengineering of production processes is lost.

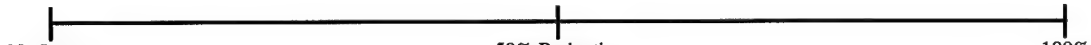
Modeling and Simulation: Aero Systems

If this contract is cut, how will it affect NAIC's ability to model and simulate foreign aero systems? At the 100% level, all ability to model and simulate aero systems is lost.



Modeling and Simulation: Basic Model Infrastructure

If this contract is cut, how will it affect NAIC's ability to develop a foundation modeling and simulation infrastructure? At the 100% level, all ability to model and simulate basic model infrastructure is lost.

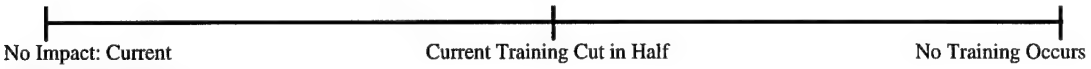


Appendix C. Scoring Sheets

UNIT PERFORMANCE

People: Training

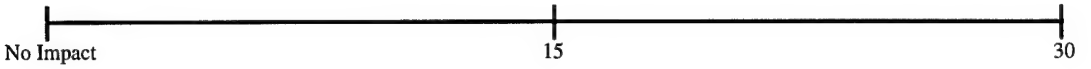
If this contract is cut, how will it affect the amount of training your personnel receive? Your organization may already not get the training it needs. Base this rating not on where you are now, but on how this contract cut will prevent your personnel from getting the training they need.



No Impact: Current Training Continues | Current Training Cut in Half | No Training Occurs

People: Quality of Life: # of Days TDY

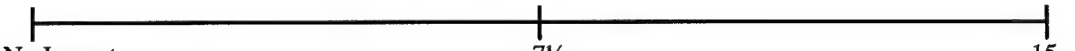
If this contract is cut, how will it affect the TDY requirements for people in your organization? Will they be required to go TDY more because requirements have increased while manpower decreased or stayed the same?



No Impact | 15 | 30

People: Quality of Life: Over Worked

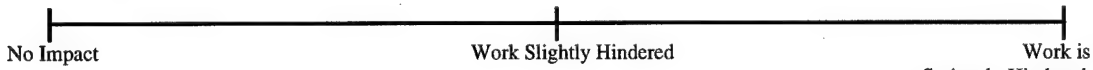
If this contract is cut, how will it affect the workload of your employees? This assumes that if your organization personnel are overworked, there is very little, if any time for communication and community work (or other activities). This scale is based on hours per week extra required to fulfill mission requirements.



No Impact | 7½ | 15

People: Quality of Life: Work Environment

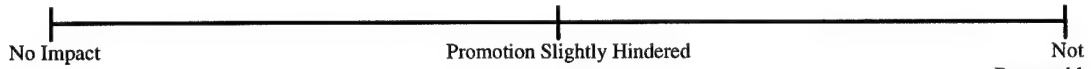
If this contract is cut, how will it affect your work environment? Is the stress level preventing work from being accomplished? Do the physical attributes in the workplace, like air quality, poor ventilation, desk/chair quality and/or placement hinder work from being accomplished?



No Impact | Work Slightly Hindered | Work is Seriously Hindered

People: Promotion Frontier

If this contract is cut, how will it affect the ability of your personnel to get promoted? In this case, consider how this cut will affect your personnel. Will they be performing tasks and jobs that would take them away from and not contribute to doing the things that are important for promotion?



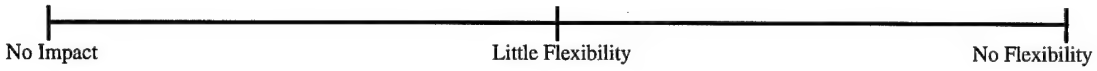
No Impact | Promotion Slightly Hindered | Not Promotable

Appendix C. Scoring Sheets

UNIT PERFORMANCE

People: Flexibility

If this contract is cut, how will it affect the flexibility of the people within your organization? Your organization may already have no flexibility. However, suppose your organization had a great deal of flexibility and now this contract cut occurs. How will it affect your organization?



People: Leadership: Communication

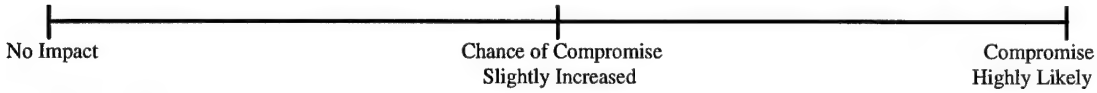
If this contract is cut, how will it affect your organization's ability to communicate with organizations internal to NAIC? Base your response upon the time available for communication, quality of communication (clear, concise, accurate) and communicating with the right person or group.

People: Leadership: Community Work

If this contract is cut, how will it affect the ability of members in your organization to perform community work? Base your response on the amount of time available for your personnel to perform community work. Keep in mind that the focus is on how much change there is after the contract is cut.

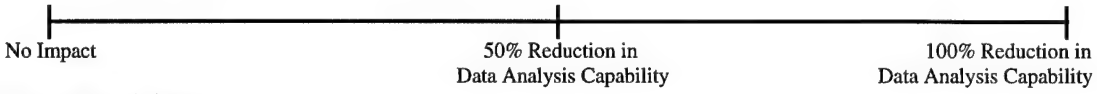
Processes: Security Concerns

If this contract is cut, how will it affect the possibility of compromising information for your organization? Consider information, physical, and personnel security along with OPSEC, COMPUSEC, COMSEC, etc. when rating this measure.



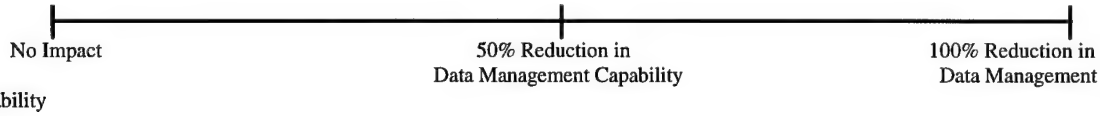
Processes: Data: Analyze

If this contract is cut, how will it affect your organization's ability to analyze data? For this scale, consider the accuracy, reliability and accessibility of the data. Would data no longer be available or would data analysis no longer be possible?



Processes: Data: Manage

If this contract is cut, how will it affect your organization's ability to manage data? Is there too much data to manage, personnel unavailable to manage the data or data management software unavailable?

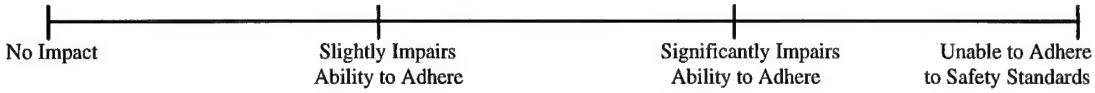


Appendix C. Scoring Sheets

UNIT PERFORMANCE

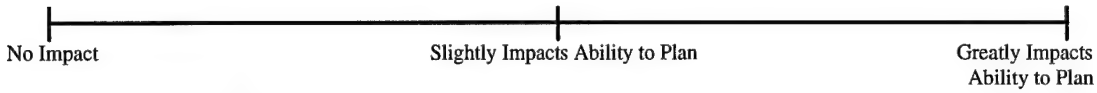
Processes: Safety

If this contract is cut, how will it affect your organization's ability to adhere to safety standards? This rating applies to an inability to adhere to safety standards. An inability to adhere is also different from attention to detail. An example would be spilling of photo lab chemicals because the lack of time to put them away.



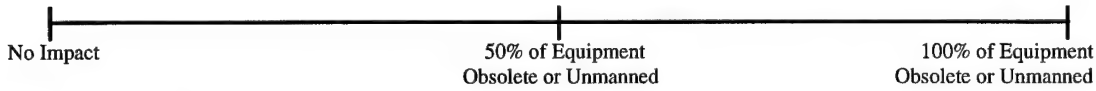
Processes: Planning

If this contract is cut, how will it affect your organization's ability to produce plans and/or respond to plans? Producing plans pertains to methods for collecting metrics, providing continuity folders, and any other type of plan that would organize or run your DU more efficiently. Responding to plans is what you are doing now through this scoring sheet and may be external or internal for your organization.



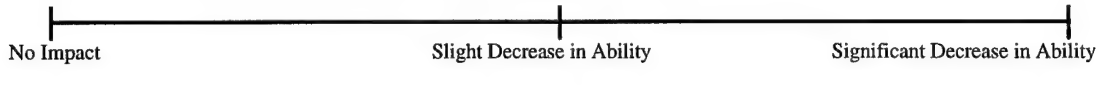
Processes: Resources: Equipment

If this contract is cut, how will it affect your organization's equipment resources? Will your equipment become obsolete or will the knowledge of how to use the equipment decrease?

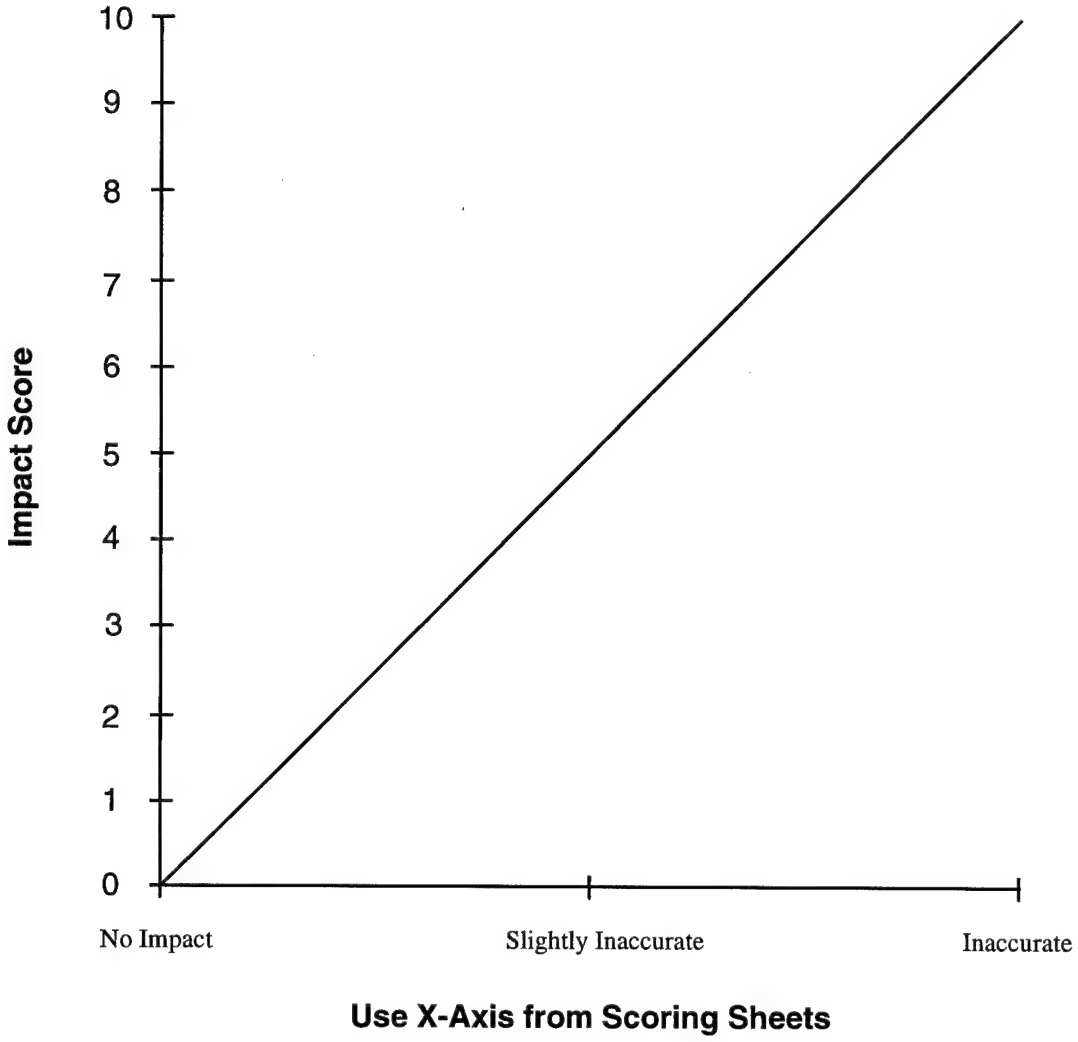


Processes: Resources: Facility

If this contract is cut, how will it affect your organization's facility resources? Consider how the facility resources affect NAIC's ability to fulfill its mission.



Appendix D. Single Dimensional Value Function



Appendix E. Manpower Breakdown

Name:_____

Date:_____

2 or 3 Letter Scored:__XX__

Prior to scoring, identify how each cut would be divided by filling in the blanks. The current breakdown of personnel within your organization is shown on the right. Also, identify when the proposed cuts will affect other manpower or contract scoring. For example, if a 9 person cut affects how another manpower level or contract is scored, check the appropriate box.

	# of Persons	Proposed			√ if Proposal Affects other	
#	To Be Cut	# of Off	# of Amn	# of Civ	Manpower	Contract
0	0	0	0	0	---	---
1	3	_____	_____	_____	_____	_____
2	6	_____	_____	_____	_____	_____
3	9	_____	_____	_____	_____	_____
4	12	_____	_____	_____	_____	_____

XX Breakdown	
Officer	16
Airmen	9
Civilian	35
Total	60

Evaluate how each of the 4 cuts will impact each of the attributes by placing the cut "#" on the attribute linescales. The "0" cut will always have no impact and is already inserted. The cut divisions that you chose should guide you throughtout the scoring of the attributes.

Acquisition: Quality: Accuracy

For each manpower cut, how will it affect the accuracy of products provided to the Acquisition Community? With accuracy, think in terms of the information provided. Will the information provided be any less accurate because of this cut?

Appendix F. Rank Ordering of Contract and Manpower Level Impact/Cost Ratios

CO = 30%, AoE = 23%, UP = 47%

Rank	Cont/MP	Impact	Dollars	MP	Impact/$	Rank	Cont/MP	Impact	Dollars	MP	Impact/$	Rank	Cont/MP	Impact	Dollars	MP	Impact/$
1	11N	0.513	1842	0	0.00028	56	7MB	0.831	260	4	0.00320	111	2ME	6.343	1029	13	0.00616
2	11O	0.481	1685	0	0.00029	57	1A	1.856	549	0	0.00338	112	2ME14	6.361	1029	13	0.00618
3	14MB	0.042	130	2	0.00032	58	6B	1.821	507	0	0.00359	113	2ME3	6.361	1029	13	0.00618
4	14MC	0.112	345	5	0.00033	59	4A	0.825	229	0	0.00360	114	10B	4.451	720	0	0.00618
5	14ME	0.222	667	10	0.00033	60	5MB	0.953	264	3	0.00361	115	2MEX2	6.379	1029	13	0.00620
6	14MD	0.163	472	7	0.00035	61	4E	1.273	347	0	0.00367	116	15MB	1.613	260	4	0.00620
7	11G	0.184	322	0	0.00057	62	5B	1.738	462	0	0.00376	117	1MCX2	3.405	547	7	0.00622
8	11K	0.141	231	0	0.00061	63	11MB	1.218	319	5	0.00382	118	16MC3	2.506	391	5	0.00641
9	11E	0.197	318	0	0.00062	64	9ME	5.892	1512	25	0.00390	119	8MB	0.509	78	2	0.00652
10	11F	1.166	1842	0	0.00063	65	18MD	2.841	728	12	0.00390	120	11Q	1.477	223	0	0.00662
11	11C	0.463	692	0	0.00067	66	3MB	1.037	264	3	0.00393	121	11D	1.197	180	0	0.00665
12	11L	0.699	967	0	0.00072	67	1ME	4.793	1205	15	0.00398	122	1MB3	2.230	306	4	0.00729
13	13MB	0.098	130	2	0.00076	68	1ME14	4.938	1205	15	0.00410	123	2MD	5.866	788	10	0.00744
14	11A	0.649	728	0	0.00089	69	17MC	1.209	283	4	0.00427	124	1MBX2	2.281	306	4	0.00745
15	6MC	0.801	732	11	0.00109	70	1MD	3.757	853	11	0.00440	125	2MD14	5.884	788	10	0.00747
16	6MB	0.335	296	5	0.00113	71	15MD	3.161	715	11	0.00442	126	11R	1.182	157	0	0.00753
17	13MC	0.267	234	4	0.00114	72	15ME	4.148	923	15	0.00449	127	2MD3	5.955	788	10	0.00756
18	11H	1.083	921	0	0.00118	73	1ME3	5.471	1205	15	0.00454	128	2MDX2	5.974	788	10	0.00758
19	6A	0.161	133	0	0.00121	74	1MEX2	5.533	1205	15	0.00459	129	2G	5.751	728	0	0.00790
20	11M	0.736	593	0	0.00124	75	15MC	2.392	520	8	0.00460	130	7D	2.157	269	0	0.00802
21	6MD	1.413	1077	16	0.00131	76	9MD	5.071	1099	19	0.00461	131	6D	0.539	67	0	0.00804
22	6ME	2.096	1464	22	0.00143	77	17MC3	1.316	283	4	0.00465	132	8MC	2.244	270	5	0.00831
23	11I	0.664	461	0	0.00144	78	10I	3.530	759	0	0.00465	133	12MC	4.642	557	8	0.00833
24	13MD	0.560	387	6	0.00145	79	1MD14	3.972	853	11	0.00466	134	10H	2.024	231	0	0.00876
25	13ME	0.930	517	8	0.00180	80	4D	1.197	252	0	0.00475	135	16MB	1.236	127	2	0.00973
26	11J	1.672	921	0	0.00182	81	9MB	1.487	312	6	0.00477	136	2MC	5.335	547	7	0.00975
27	11B	0.544	286	0	0.00190	82	1MC	2.627	547	7	0.00480	137	2MC14	5.355	547	7	0.00979
28	4C	1.704	893	0	0.00191	83	4ME	4.320	899	11	0.00481	138	10D	2.804	282	0	0.00994
29	1D	0.837	429	0	0.00195	84	4MB	1.163	241	3	0.00483	139	8ME	5.536	553	9	0.01001
30	10MB	0.917	452	7	0.00203	85	4MC	2.329	482	6	0.00483	140	2MC3	5.507	547	7	0.01007
31	11ME	2.813	1305	20	0.00216	86	16ME	3.629	720	9	0.00504	141	2MCX2	5.528	547	7	0.01011
32	3ME	2.169	987	12	0.00220	87	4MD	3.332	658	8	0.00506	142	11P	0.943	92	0	0.01025
33	11MC	1.521	664	10	0.00229	88	1MB	1.553	306	4	0.00508	143	8MD	4.395	423	7	0.01039
34	3MD	1.779	746	9	0.00238	89	17ME	3.148	612	8	0.00514	144	18MB	2.229	208	4	0.01072
35	4B	1.178	492	0	0.00239	90	1MD3	4.461	853	11	0.00523	145	16MB3	1.433	127	2	0.01128
36	1C	1.838	767	0	0.00240	91	12ME	6.236	1192	16	0.00523	146	3A	1.467	129	0	0.01137
37	11MD	2.308	960	15	0.00240	92	1MC14	2.883	547	7	0.00527	147	1F	2.556	215	0	0.01189
38	10MC	2.200	878	14	0.00251	93	16ME3	3.796	720	9	0.00527	148	12MB	3.857	303	4	0.01273
39	7E	2.323	891	0	0.00261	94	17MD	2.437	459	6	0.00531	149	2B	5.904	428	0	0.01379
40	17MB	0.399	153	2	0.00261	95	1MDX2	4.534	853	11	0.00532	150	2F	5.704	408	0	0.01398
41	3MC	1.405	528	6	0.00266	96	18MC	2.510	468	8	0.00536	151	2C	5.716	384	0	0.01489
42	5MC	1.692	616	7	0.00275	97	10E	2.844	527	0	0.00540	152	10F	2.222	133	0	0.01671
43	7A	2.714	948	0	0.00286	98	17ME3	3.303	612	8	0.00540	153	9A	5.995	354	0	0.01693
44	10MD	3.727	1301	21	0.00286	99	9MC	3.713	686	13	0.00541	154	2MB	4.736	241	3	0.01965
45	5ME	3.542	1232	14	0.00287	100	5A	2.754	507	0	0.00543	155	2MB14	4.755	241	3	0.01973
46	1E	0.781	266	0	0.00294	101	16MD	2.998	544	7	0.00551	156	10A	5.769	290	0	0.01989
47	7MC	1.538	520	8	0.00296	102	17MD3	2.576	459	6	0.00561	157	2MB3	5.027	241	3	0.02086
48	17MB3	0.454	153	2	0.00297	103	6C	1.423	252	0	0.00565	158	2MBX2	5.047	241	3	0.02094
49	7MD	2.314	780	12	0.00297	104	1MB14	1.762	306	4	0.00576	159	2H	5.785	266	0	0.02175
50	1B	1.061	354	0	0.00300	105	8A	4.586	792	0	0.00579	160	2D	5.696	198	0	0.02877
51	7ME	3.138	1040	16	0.00302	106	16MD3	3.175	544	7	0.00584	161	7C	2.709	89	0	0.03044
52	5C	3.908	1288	0	0.00303	107	10C	2.821	481	0	0.00587	162	2A	5.244	112	0	0.04682
53	10ME	5.176	1675	28	0.00309	108	16MC	2.333	391	5	0.00597	163	2E	5.781	112	0	0.05162
54	5MD	2.792	880	10	0.00317	109	12MD	5.434	909	12	0.00598	164	10G	3.395	38	0	0.08934
55	18ME	3.128	985	16	0.00318	110	1MC3	3.335	547	7	0.00610						

Appendix F. Rank Ordering of Contract and Manpower Level Impact/Cost Ratios

CO = 50%, AoE = 17%, UP = 33%

Rank	Cont/MP	Impact	Dollars	MP	Impact/$	Rank	Cont/MP	Impact	Dollars	MP	Impact/$	Rank	Cont/MP	Impact	Dollars	MP	Impact/$
1	11N	0.663	1842	0	0.00036	56	1ME14	4.877	1205	15	0.00405	111	6C	1.736	252	0	0.00689
2	11O	0.669	1685	0	0.00040	57	5MD	3.564	880	10	0.00405	112	8A	5.466	792	0	0.00690
3	14MB	0.069	130	2	0.00053	58	17MC	1.159	283	4	0.00409	113	5A	3.517	507	0	0.00694
4	13MB	0.070	130	2	0.00054	59	18MC	1.935	468	8	0.00413	114	2ME	7.328	1029	13	0.00712
5	14MC	0.187	345	5	0.00054	60	6B	2.182	507	0	0.00430	115	16MC	2.786	391	5	0.00713
6	14ME	0.370	667	10	0.00056	61	1MD	3.738	853	11	0.00438	116	2ME3	7.341	1029	13	0.00713
7	14MD	0.272	472	7	0.00058	62	9ME	6.742	1512	25	0.00446	117	2ME14	7.358	1029	13	0.00715
8	11K	0.147	231	0	0.00064	63	1E	1.188	266	0	0.00447	118	2MEX2	7.371	1029	13	0.00716
9	11G	0.211	322	0	0.00065	64	17MC3	1.268	283	4	0.00448	119	10C	3.463	481	0	0.00720
10	11F	1.242	1842	0	0.00067	65	4E	1.560	347	0	0.00450	120	10H	1.670	231	0	0.00723
11	11C	0.469	692	0	0.00068	66	5B	2.100	462	0	0.00455	121	16MC3	2.942	391	5	0.00752
12	13MC	0.190	234	4	0.00081	67	1ME3	5.551	1205	15	0.00461	122	7D	2.046	269	0	0.00761
13	11E	0.277	318	0	0.00087	68	1MD14	3.940	853	11	0.00462	123	1MB3	2.370	306	4	0.00775
14	13MD	0.400	387	6	0.00103	69	5MB	1.223	264	3	0.00463	124	1MBX2	2.406	306	4	0.00786
15	11L	1.030	967	0	0.00107	70	1MEX2	5.595	1205	15	0.00464	125	18MB	1.649	208	4	0.00793
16	6A	0.152	133	0	0.00114	71	15MD	3.349	715	11	0.00468	126	8MC	2.216	270	5	0.00821
17	11A	0.907	728	0	0.00125	72	4A	1.073	229	0	0.00468	127	2MD	6.891	788	10	0.00874
18	6MC	0.939	732	11	0.00128	73	1A	2.575	549	0	0.00469	128	2MD14	6.922	788	10	0.00878
19	13ME	0.664	517	8	0.00128	74	1B	1.685	354	0	0.00476	129	2MD3	6.954	788	10	0.00883
20	6MB	0.399	296	5	0.00135	75	15MC	2.488	520	8	0.00478	130	2MDX2	6.985	788	10	0.00886
21	11H	1.278	921	0	0.00139	76	1MC	2.652	547	7	0.00485	131	11Q	1.991	223	0	0.00893
22	6MD	1.587	1077	16	0.00147	77	15ME	4.495	923	15	0.00487	132	12MC	4.977	557	8	0.00893
23	6ME	2.285	1464	22	0.00156	78	10I	3.953	759	0	0.00521	133	2G	6.965	728	0	0.00957
24	11I	0.774	461	0	0.00168	79	1MB	1.596	306	4	0.00522	134	11D	1.756	180	0	0.00976
25	11M	1.202	593	0	0.00203	80	3MB	1.383	264	3	0.00524	135	11R	1.610	157	0	0.01025
26	10MB	0.941	452	7	0.00208	81	1MC14	2.891	547	7	0.00529	136	8ME	5.877	553	9	0.01063
27	11B	0.671	286	0	0.00234	82	4ME	4.767	899	11	0.00530	137	8MD	4.715	423	7	0.01115
28	17MB	0.364	153	2	0.00238	83	4MC	2.556	482	6	0.00530	138	2MC	6.382	547	7	0.01167
29	4C	2.180	893	0	0.00244	84	1MD3	4.539	853	11	0.00532	139	2MC14	6.416	547	7	0.01173
30	10MC	2.192	878	14	0.00250	85	9MD	5.876	1099	19	0.00535	140	2MC3	6.506	547	7	0.01189
31	11J	2.315	921	0	0.00251	86	1MDX2	4.591	853	11	0.00538	141	2MCX2	6.539	547	7	0.01195
32	1D	1.100	429	0	0.00256	87	4MB	1.312	241	3	0.00544	142	16MB	1.542	127	2	0.01214
33	18ME	2.544	985	16	0.00258	88	12ME	6.639	1192	16	0.00557	143	10D	3.507	282	0	0.01244
34	7E	2.371	891	0	0.00266	89	4MD	3.667	658	8	0.00557	144	1F	2.796	215	0	0.01300
35	17MB3	0.413	153	2	0.00270	90	17MD	2.597	459	6	0.00566	145	10F	1.758	133	0	0.01322
36	7A	2.584	948	0	0.00273	91	17ME	3.498	612	8	0.00572	146	16MB3	1.719	127	2	0.01353
37	10MD	3.547	1301	21	0.00273	92	1MB14	1.785	306	4	0.00583	147	12MB	4.162	303	4	0.01374
38	3ME	2.720	987	12	0.00276	93	16ME	4.209	720	9	0.00585	148	3A	1.829	129	0	0.01418
39	10ME	4.858	1675	28	0.00290	94	17MD3	2.738	459	6	0.00597	149	11P	1.477	92	0	0.01606
40	7MC	1.571	520	8	0.00302	95	17ME3	3.657	612	8	0.00598	150	2B	6.943	428	0	0.01622
41	3MD	2.257	746	9	0.00303	96	16ME3	4.363	720	9	0.00606	151	2F	6.725	408	0	0.01648
42	4B	1.504	492	0	0.00306	97	4D	1.530	252	0	0.00607	152	2C	6.809	384	0	0.01773
43	7MB	0.797	260	4	0.00307	98	9MB	1.934	312	6	0.00620	153	9A	6.942	354	0	0.01961
44	18MD	2.256	728	12	0.00310	99	11MB	1.980	319	5	0.00621	154	10A	6.140	290	0	0.02117
45	7MD	2.420	780	12	0.00310	100	1MC3	3.452	547	7	0.00631	155	2MB	5.823	241	3	0.02416
46	1C	2.407	767	0	0.00314	101	9MC	4.368	686	13	0.00637	156	2MB14	5.855	241	3	0.02429
47	7ME	3.360	1040	16	0.00323	102	12MD	5.801	909	12	0.00638	157	2MB3	6.031	241	3	0.02502
48	11ME	4.401	1305	20	0.00337	103	1MCX2	3.502	547	7	0.00640	158	2MBX2	6.063	241	3	0.02516
49	3MC	1.812	528	6	0.00343	104	16MD	3.519	544	7	0.00647	159	2H	6.989	266	0	0.02628
50	5C	4.447	1288	0	0.00345	105	6D	0.436	67	0	0.00651	160	2D	6.795	198	0	0.03432
51	5MC	2.135	616	7	0.00347	106	15MB	1.702	260	4	0.00655	161	7C	3.305	89	0	0.03714
52	5ME	4.316	1232	14	0.00350	107	10E	3.491	527	0	0.00662	162	2A	6.107	112	0	0.05452
53	11MC	2.482	664	10	0.00374	108	8MB	0.522	78	2	0.00670	163	2E	6.855	112	0	0.06120
54	11MD	3.688	960	15	0.00384	109	16MD3	3.690	544	7	0.00678	164	10G	3.193	38	0	0.08403
55	1ME	4.710	1205	15	0.00391	110	10B	4.955	720	0	0.00688						

Appendix F. Rank Ordering of Contract and Manpower Level Impact/Cost Ratios

CO = 45%, AoE = 10%, UP = 45%

Rank	Cont/MP	Impact	Dollars	MP	Impact/$	Rank	Cont/MP	Impact	Dollars	MP	Impact/$	Rank	Cont/MP	Impact	Dollars	MP	Impact/$
1	11N	0.581	1842	0	0.00032	56	18MD	2.782	728	12	0.00382	111	10E	3.440	527	0	0.00653
2	11O	0.595	1685	0	0.00035	57	4A	0.906	229	0	0.00396	112	1MC3	3.582	547	7	0.00655
3	14MB	0.062	130	2	0.00048	58	6B	2.049	507	0	0.00404	113	16MD3	3.582	544	7	0.00658
4	14MC	0.169	345	5	0.00049	59	1E	1.082	266	0	0.00407	114	8A	5.283	792	0	0.00667
5	14ME	0.333	667	10	0.00050	60	5B	1.922	462	0	0.00416	115	1MCX2	3.650	547	7	0.00667
6	14MD	0.245	472	7	0.00052	61	1ME	5.020	1205	15	0.00417	116	16MC	2.650	391	5	0.00678
7	11F	1.020	1842	0	0.00055	62	5MB	1.110	264	3	0.00421	117	8MB	0.541	78	2	0.00694
8	11G	0.180	322	0	0.00056	63	9ME	6.386	1512	25	0.00422	118	15MB	1.809	260	4	0.00696
9	11K	0.136	231	0	0.00059	64	1A	2.327	549	0	0.00424	119	6D	0.468	67	0	0.00698
10	11C	0.414	692	0	0.00060	65	1ME14	5.189	1205	15	0.00431	120	7D	1.904	269	0	0.00708
11	13MB	0.095	130	2	0.00073	66	1B	1.525	354	0	0.00431	121	16MC3	2.810	391	5	0.00719
12	11E	0.267	318	0	0.00084	67	17MC	1.300	283	4	0.00459	122	2MD	6.107	788	10	0.00775
13	11L	0.916	967	0	0.00095	68	1MD	3.972	853	11	0.00466	123	2MD14	6.135	788	10	0.00779
14	6A	0.130	133	0	0.00098	69	15MD	3.391	715	11	0.00474	124	11Q	1.738	223	0	0.00779
15	13MC	0.257	234	4	0.00110	70	3MB	1.257	264	3	0.00476	125	2MD3	6.145	788	10	0.00780
16	11A	0.806	728	0	0.00111	71	1ME3	5.759	1205	15	0.00478	126	2MDX2	6.174	788	10	0.00783
17	11H	1.092	921	0	0.00119	72	4MC	2.305	482	6	0.00478	127	1MB3	2.437	306	4	0.00796
18	6MC	0.905	732	11	0.00124	73	1MEX2	5.818	1205	15	0.00483	128	1MBX2	2.486	306	4	0.00812
19	6MB	0.385	296	5	0.00130	74	15ME	4.464	923	15	0.00484	129	2G	5.998	728	0	0.00824
20	13MD	0.540	387	6	0.00140	75	4ME	4.374	899	11	0.00487	130	8MC	2.229	270	5	0.00825
21	11I	0.651	461	0	0.00141	76	4MB	1.180	241	3	0.00490	131	12MC	4.599	557	8	0.00826
22	6MD	1.548	1077	16	0.00144	77	1MD14	4.200	853	11	0.00492	132	11D	1.527	180	0	0.00848
23	6ME	2.251	1464	22	0.00154	78	17MC3	1.405	283	4	0.00496	133	10H	1.982	231	0	0.00858
24	13ME	0.897	517	8	0.00173	79	9MD	5.499	1099	19	0.00500	134	11R	1.420	157	0	0.00904
25	11M	1.076	593	0	0.00181	80	15MC	2.617	520	8	0.00503	135	2MC	5.634	547	7	0.01030
26	11B	0.574	286	0	0.00201	81	4MD	3.334	658	8	0.00507	136	2MC14	5.665	547	7	0.01036
27	4C	1.852	893	0	0.00207	82	4D	1.295	252	0	0.00514	137	18MB	2.157	208	4	0.01037
28	11J	2.010	921	0	0.00218	83	1MC	2.817	547	7	0.00515	138	2MC3	5.708	547	7	0.01044
29	10MB	0.994	452	7	0.00220	84	18MC	2.449	468	8	0.00523	139	2MCX2	5.738	547	7	0.01049
30	1D	0.961	429	0	0.00224	85	12ME	6.265	1192	16	0.00526	140	8ME	5.810	553	9	0.01051
31	7E	2.167	891	0	0.00243	86	10I	4.123	759	0	0.00543	141	8MD	4.677	423	7	0.01106
32	3ME	2.462	987	12	0.00249	87	1MD3	4.724	853	11	0.00554	142	16MB	1.520	127	2	0.01197
33	4B	1.277	492	0	0.00260	88	1MB	1.702	306	4	0.00556	143	10D	3.429	282	0	0.01216
34	7A	2.512	948	0	0.00265	89	1MDX2	4.794	853	11	0.00562	144	12MB	3.777	303	4	0.01247
35	10MC	2.337	878	14	0.00266	90	11MB	1.799	319	5	0.00564	145	1F	2.805	215	0	0.01305
36	3MD	2.048	746	9	0.00275	91	1MC14	3.089	547	7	0.00565	146	3A	1.699	129	0	0.01317
37	17MB	0.423	153	2	0.00276	92	16ME	4.127	720	9	0.00573	147	16MB3	1.689	127	2	0.01330
38	10MD	3.651	1301	21	0.00281	93	17ME	3.556	612	8	0.00581	148	2B	6.072	428	0	0.01419
39	1C	2.161	767	0	0.00282	94	17MD	2.714	459	6	0.00591	149	2F	5.797	408	0	0.01421
40	7MC	1.524	520	8	0.00293	95	16ME3	4.292	720	9	0.00596	150	11P	1.335	92	0	0.01451
41	10ME	4.981	1675	28	0.00297	96	12MD	5.426	909	12	0.00597	151	2C	5.891	384	0	0.01534
42	7MD	2.325	780	12	0.00298	97	9MC	4.102	686	13	0.00598	152	10F	2.138	133	0	0.01608
43	7MB	0.786	260	4	0.00302	98	9MB	1.880	312	6	0.00603	153	9A	6.698	354	0	0.01892
44	11ME	3.956	1305	20	0.00303	99	17ME3	3.706	612	8	0.00606	154	10A	6.137	290	0	0.02116
45	17MB3	0.468	153	2	0.00306	100	10B	4.430	720	0	0.00615	155	2MB	5.148	241	3	0.02136
46	7ME	3.212	1040	16	0.00309	101	17MD3	2.848	459	6	0.00621	156	2MB14	5.177	241	3	0.02148
47	3MC	1.645	528	6	0.00312	102	10C	2.995	481	0	0.00623	157	2MB3	5.273	241	3	0.02188
48	18ME	3.077	985	16	0.00312	103	16MD	3.405	544	7	0.00626	158	2MBX2	5.302	241	3	0.02200
49	5MC	1.975	616	7	0.00321	104	1MB14	1.920	306	4	0.00627	159	2H	6.049	266	0	0.02274
50	5ME	4.061	1232	14	0.00330	105	2ME	6.511	1029	13	0.00633	160	2D	5.881	198	0	0.02970
51	5C	4.307	1288	0	0.00334	106	5A	3.209	507	0	0.00633	161	7C	2.845	89	0	0.03197
52	11MC	2.250	664	10	0.00339	107	2ME3	6.519	1029	13	0.00634	162	2A	5.372	112	0	0.04797
53	11MD	3.343	960	15	0.00348	108	2ME14	6.538	1029	13	0.00635	163	2E	5.914	112	0	0.05281
54	4E	1.300	347	0	0.00375	109	2MEX2	6.546	1029	13	0.00636	164	10G	3.424	38	0	0.09011
55	5MD	3.319	880	10	0.00377	110	6C	1.623	252	0	0.00644						

Appendix F. Rank Ordering of Contract and Manpower Level Impact/Cost Ratios

CO = 35%, AoE = 30%, UP = 35%

Rank	Cont/MP	Impact	Dollars	MP	Impact/$	Rank	Cont/MP	Impact	Dollars	MP	Impact/$	Rank	Cont/MP	Impact	Dollars	MP	Impact/$
1	11N	0.595	1842	0	0.00032	56	1B	1.221	354	0	0.00345	111	16MC	2.469	391	5	0.00631
2	11O	0.555	1685	0	0.00033	57	5MD	3.036	880	10	0.00345	112	12MD	5.808	909	12	0.00639
3	14MB	0.049	130	2	0.00037	58	1ME	4.484	1205	15	0.00372	113	16MC3	2.638	391	5	0.00675
4	14MC	0.131	345	5	0.00038	59	17MC	1.068	283	4	0.00377	114	10C	3.289	481	0	0.00684
5	14ME	0.259	667	10	0.00039	60	1A	2.104	549	0	0.00383	115	10B	4.976	720	0	0.00691
6	14MD	0.191	472	7	0.00040	61	1ME14	4.627	1205	15	0.00384	116	2ME	7.160	1029	13	0.00696
7	13MB	0.074	130	2	0.00057	62	6B	1.954	507	0	0.00385	117	2ME14	7.181	1029	13	0.00698
8	11E	0.208	318	0	0.00065	63	5MB	1.065	264	3	0.00404	118	2ME3	7.183	1029	13	0.00698
9	11K	0.152	231	0	0.00066	64	1MD	3.523	853	11	0.00413	119	2MEX2	7.204	1029	13	0.00700
10	11G	0.215	322	0	0.00067	65	9ME	6.247	1512	25	0.00413	120	1MB3	2.163	306	4	0.00707
11	11C	0.519	692	0	0.00075	66	5B	1.916	462	0	0.00415	121	1MBX2	2.201	306	4	0.00719
12	11F	1.388	1842	0	0.00075	67	17MC3	1.179	283	4	0.00417	122	10H	1.712	231	0	0.00741
13	11L	0.813	967	0	0.00084	68	18MC	1.995	468	8	0.00426	123	6D	0.507	67	0	0.00757
14	13MC	0.200	234	4	0.00085	69	4A	0.992	229	0	0.00433	124	11Q	1.730	223	0	0.00776
15	11A	0.750	728	0	0.00103	70	15MC	2.262	520	8	0.00435	125	11D	1.426	180	0	0.00792
16	13MD	0.420	387	6	0.00109	71	1MD14	3.711	853	11	0.00435	126	8MC	2.231	270	5	0.00826
17	6MC	0.835	732	11	0.00114	72	15MD	3.119	715	11	0.00436	127	18MB	1.721	208	4	0.00828
18	6MB	0.349	296	5	0.00118	73	1ME3	5.263	1205	15	0.00437	128	2MD	6.649	788	10	0.00844
19	6MD	1.453	1077	16	0.00135	74	11MB	1.399	319	5	0.00439	129	2MD14	6.671	788	10	0.00847
20	13ME	0.697	517	8	0.00135	75	1MEX2	5.309	1205	15	0.00441	130	7D	2.299	269	0	0.00855
21	6A	0.183	133	0	0.00138	76	3MB	1.163	264	3	0.00441	131	2MD3	6.764	788	10	0.00858
22	11H	1.269	921	0	0.00138	77	4E	1.532	347	0	0.00441	132	2MDX2	6.785	788	10	0.00861
23	11M	0.862	593	0	0.00145	78	10I	3.361	759	0	0.00443	133	11R	1.373	157	0	0.00874
24	6ME	2.130	1464	22	0.00145	79	1MC	2.462	547	7	0.00450	134	12MC	5.020	557	8	0.00901
25	11I	0.788	461	0	0.00171	80	15ME	4.179	923	15	0.00453	135	2G	6.719	728	0	0.00923
26	10MB	0.863	452	7	0.00191	81	1MB	1.448	306	4	0.00473	136	16MB	1.258	127	2	0.00991
27	11J	1.977	921	0	0.00215	82	1MC14	2.685	547	7	0.00491	137	8ME	5.603	553	9	0.01013
28	17MB	0.340	153	2	0.00223	83	9MB	1.541	312	6	0.00494	138	10D	2.882	282	0	0.01022
29	11B	0.641	286	0	0.00224	84	9MD	5.448	1099	19	0.00496	139	8MD	4.434	423	7	0.01048
30	1D	0.976	429	0	0.00227	85	1MD3	4.276	853	11	0.00501	140	2MC	6.083	547	7	0.01112
31	4C	2.033	893	0	0.00228	86	17ME	3.091	612	8	0.00505	141	2MC14	6.107	547	7	0.01116
32	10MC	2.055	878	14	0.00234	87	17MD	2.320	459	6	0.00505	142	16MB3	1.462	127	2	0.01151
33	3ME	2.426	987	12	0.00246	88	1MDX2	4.331	853	11	0.00508	143	2MC3	6.305	547	7	0.01153
34	11ME	3.258	1305	20	0.00250	89	16ME	3.711	720	9	0.00515	144	2MCX2	6.328	547	7	0.01157
35	17MB3	0.399	153	2	0.00261	90	4ME	4.713	899	11	0.00524	145	11P	1.086	92	0	0.01180
36	18ME	2.595	985	16	0.00263	91	1MB14	1.626	306	4	0.00531	146	1F	2.546	215	0	0.01184
37	11MC	1.752	664	10	0.00264	92	17ME3	3.254	612	8	0.00532	147	3A	1.597	129	0	0.01238
38	3MD	1.988	746	9	0.00266	93	4MC	2.580	482	6	0.00535	148	10F	1.842	133	0	0.01385
39	1C	2.085	767	0	0.00272	94	16ME3	3.868	720	9	0.00537	149	12MB	4.242	303	4	0.01400
40	11MD	2.652	960	15	0.00276	95	17MD3	2.466	459	6	0.00537	150	2B	6.774	428	0	0.01583
41	10MD	3.623	1301	21	0.00279	96	4MB	1.295	241	3	0.00537	151	2F	6.632	408	0	0.01625
42	7E	2.527	891	0	0.00284	97	10E	2.894	527	0	0.00549	152	2C	6.634	384	0	0.01728
43	4B	1.405	492	0	0.00286	98	12ME	6.610	1192	16	0.00555	153	9A	6.239	354	0	0.01762
44	7A	2.787	948	0	0.00294	99	4MD	3.665	658	8	0.00557	154	10A	5.771	290	0	0.01990
45	3MC	1.572	528	6	0.00298	100	4D	1.433	252	0	0.00568	155	2MB	5.410	241	3	0.02245
46	5MC	1.852	616	7	0.00301	101	16MD	3.113	544	7	0.00572	156	2MB14	5.433	241	3	0.02254
47	10ME	5.052	1675	28	0.00302	102	15MB	1.506	260	4	0.00579	157	2MB3	5.785	241	3	0.02400
48	7MC	1.585	520	8	0.00305	103	9MC	3.978	686	13	0.00580	158	2MBX2	5.808	241	3	0.02410
49	5ME	3.796	1232	14	0.00308	104	1MC3	3.205	547	7	0.00586	159	2H	6.726	266	0	0.02528
50	7MD	2.409	780	12	0.00309	105	1MCX2	3.257	547	7	0.00596	160	2D	6.610	198	0	0.03338
51	5C	4.049	1288	0	0.00314	106	8A	4.770	792	0	0.00602	161	7C	3.170	89	0	0.03562
52	7ME	3.286	1040	16	0.00316	107	16MD3	3.283	544	7	0.00603	162	2A	5.979	112	0	0.05338
53	18MD	2.316	728	12	0.00318	108	5A	3.062	507	0	0.00604	163	2E	6.722	112	0	0.06001
54	7MB	0.843	260	4	0.00324	109	6C	1.536	252	0	0.00609	164	10G	3.164	38	0	0.08326
55	1E	0.887	266	0	0.00333	110	8MB	0.490	78	2	0.00628						

Appendix F. Rank Ordering of Contract and Manpower Level Impact/Cost Ratios

CO = 47%, AoE = 23%, UP = 30%

Rank	Cont/MP	Impact	Dollars	MP	Impact/$	Rank	Cont/MP	Impact	Dollars	MP	Impact/$	Rank	Cont/MP	Impact	Dollars	MP	Impact/$
1	11N	0.668	1842	0	0.00036	56	18MC	1.783	468	8	0.00381	111	6C	1.707	252	0	0.00677
2	11O	0.656	1685	0	0.00039	57	17MC	1.081	283	4	0.00382	112	10H	1.580	231	0	0.00684
3	13MB	0.063	130	2	0.00049	58	1ME14	4.690	1205	15	0.00389	113	5A	3.469	507	0	0.00684
4	14MB	0.065	130	2	0.00050	59	5MD	3.469	880	10	0.00394	114	16MC	2.726	391	5	0.00697
5	14MC	0.175	345	5	0.00051	60	1MD	3.589	853	11	0.00421	115	10B	5.137	720	0	0.00713
6	14ME	0.346	667	10	0.00052	61	17MC3	1.193	283	4	0.00422	116	18MB	1.504	208	4	0.00723
7	14MD	0.254	472	7	0.00054	62	1E	1.123	266	0	0.00422	117	2ME	7.544	1029	13	0.00733
8	11K	0.152	231	0	0.00066	63	6B	2.151	507	0	0.00424	118	2ME3	7.562	1029	13	0.00735
9	11G	0.222	322	0	0.00069	64	1MD14	3.777	853	11	0.00443	119	2ME14	7.572	1029	13	0.00736
10	11C	0.504	692	0	0.00073	65	9ME	6.695	1512	25	0.00443	120	2MEX2	7.590	1029	13	0.00738
11	13MC	0.171	234	4	0.00073	66	1ME3	5.386	1205	15	0.00447	121	16MC3	2.884	391	5	0.00738
12	11F	1.364	1842	0	0.00074	67	1B	1.584	354	0	0.00447	122	10C	3.561	481	0	0.00740
13	11E	0.258	318	0	0.00081	68	1MEX2	5.426	1205	15	0.00450	123	1MB3	2.279	306	4	0.00745
14	13MD	0.360	387	6	0.00093	69	5B	2.098	462	0	0.00454	124	1MBX2	2.312	306	4	0.00755
15	11L	0.995	967	0	0.00103	70	1A	2.500	549	0	0.00455	125	7D	2.178	269	0	0.00810
16	13ME	0.598	517	8	0.00116	71	15MD	3.258	715	11	0.00456	126	8MC	2.216	270	5	0.00821
17	11A	0.889	728	0	0.00122	72	15MC	2.370	520	8	0.00456	127	11Q	1.988	223	0	0.00891
18	6MC	0.916	732	11	0.00125	73	5MB	1.208	264	3	0.00457	128	2MD	7.071	788	10	0.00897
19	6A	0.170	133	0	0.00128	74	1MC	2.534	547	7	0.00463	129	2MD14	7.100	788	10	0.00901
20	6MB	0.387	296	5	0.00131	75	4E	1.637	347	0	0.00472	130	2MD3	7.160	788	10	0.00909
21	6MD	1.555	1077	16	0.00144	76	15ME	4.400	923	15	0.00477	131	2MDX2	7.189	788	10	0.00912
22	11H	1.337	921	0	0.00145	77	4A	1.101	229	0	0.00481	132	12MC	5.117	557	8	0.00919
23	6ME	2.245	1464	22	0.00153	78	10I	3.699	759	0	0.00487	133	11D	1.722	180	0	0.00957
24	11I	0.820	461	0	0.00178	79	1MB	1.511	306	4	0.00494	134	2G	7.205	728	0	0.00990
25	11M	1.130	593	0	0.00191	80	1MC14	2.756	547	7	0.00504	135	11R	1.594	157	0	0.01015
26	10MB	0.897	452	7	0.00198	81	3MB	1.352	264	3	0.00512	136	8ME	5.808	553	9	0.01050
27	17MB	0.337	153	2	0.00220	82	1MD3	4.390	853	11	0.00515	137	8MD	4.634	423	7	0.01096
28	10MC	2.098	878	14	0.00239	83	1MDX2	4.437	853	11	0.00520	138	16MB	1.455	127	2	0.01145
29	18ME	2.383	985	16	0.00242	84	9MD	5.859	1099	19	0.00533	139	10D	3.325	282	0	0.01179
30	11B	0.693	286	0	0.00242	85	17MD	2.466	459	6	0.00537	140	2MC	6.532	547	7	0.01194
31	11J	2.304	921	0	0.00250	86	4ME	4.880	899	11	0.00543	141	2MC14	6.563	547	7	0.01200
32	4C	2.240	893	0	0.00251	87	17ME	3.343	612	8	0.00546	142	2MC3	6.704	547	7	0.01226
33	17MB3	0.391	153	2	0.00255	88	4MC	2.648	482	6	0.00549	143	2MCX2	6.736	547	7	0.01231
34	1D	1.105	429	0	0.00257	89	1MB14	1.687	306	4	0.00551	144	10F	1.659	133	0	0.01247
35	10MD	3.538	1301	21	0.00272	90	4MB	1.350	241	3	0.00560	145	1F	2.709	215	0	0.01260
36	3ME	2.708	987	12	0.00274	91	16ME	4.071	720	9	0.00565	146	16MB3	1.643	127	2	0.01294
37	7E	2.490	891	0	0.00280	92	12ME	6.754	1192	16	0.00567	147	3A	1.795	129	0	0.01391
38	7A	2.676	948	0	0.00282	93	17MD3	2.611	459	6	0.00569	148	12MB	4.317	303	4	0.01425
39	18MD	2.101	728	12	0.00289	94	17ME3	3.507	612	8	0.00573	149	11P	1.394	92	0	0.01516
40	10ME	4.882	1675	28	0.00291	95	4MD	3.777	658	8	0.00574	150	2B	7.176	428	0	0.01677
41	3MD	2.237	746	9	0.00300	96	11MB	1.846	319	5	0.00579	151	2F	7.003	408	0	0.01716
42	7MC	1.591	520	8	0.00306	97	9MB	1.821	312	6	0.00584	152	2C	7.057	384	0	0.01838
43	1C	2.382	767	0	0.00311	98	16ME3	4.222	720	9	0.00586	153	9A	6.789	354	0	0.01918
44	7MB	0.816	260	4	0.00314	99	1MC3	3.327	547	7	0.00608	154	10A	6.018	290	0	0.02075
45	7MD	2.448	780	12	0.00314	100	15MB	1.601	260	4	0.00616	155	2MB	5.910	241	3	0.02452
46	4B	1.547	492	0	0.00314	101	1MCX2	3.372	547	7	0.00616	156	2MB14	5.940	241	3	0.02465
47	11ME	4.168	1305	20	0.00319	102	4D	1.576	252	0	0.00626	157	2MB3	6.202	241	3	0.02573
48	7ME	3.385	1040	16	0.00325	103	10E	3.309	527	0	0.00628	158	2MBX2	6.232	241	3	0.02586
49	5C	4.362	1288	0	0.00339	104	16MD	3.422	544	7	0.00629	159	2H	7.215	266	0	0.02712
50	3MC	1.788	528	6	0.00339	105	9MC	4.326	686	13	0.00631	160	2D	7.037	198	0	0.03554
51	5MC	2.094	616	7	0.00340	106	8MB	0.505	78	2	0.00648	161	7C	3.414	89	0	0.03836
52	5ME	4.228	1232	14	0.00343	107	12MD	5.928	909	12	0.00652	162	2A	6.309	112	0	0.05633
53	11MC	2.316	664	10	0.00349	108	16MD3	3.590	544	7	0.00660	163	2E	7.124	112	0	0.06361
54	11MD	3.457	960	15	0.00360	109	8A	5.295	792	0	0.00669	164	10G	3.106	38	0	0.08174
55	1ME	4.532	1205	15	0.00376	110	6D	0.449	67	0	0.00671						

Appendix F. Rank Ordering of Contract and Manpower Level Impact/Cost Ratios

CO = 33%, AoE = 17%, UP = 50%

Rank	Cont/MP	Impact	Dollars	MP	Impact/$	Rank	Cont/MP	Impact	Dollars	MP	Impact/$	Rank	Cont/MP	Impact	Dollars	MP	Impact/$
1	11N	0.508	1842	0	0.00028	56	18ME	3.288	985	16	0.00334	111	8A	4.757	792	0	0.00601
2	11O	0.495	1685	0	0.00029	57	4E	1.195	347	0	0.00344	112	16MD3	3.275	544	7	0.00602
3	14MB	0.046	130	2	0.00036	58	4A	0.796	229	0	0.00348	113	1MB14	1.860	306	4	0.00608
4	14MC	0.125	345	5	0.00036	59	1A	1.931	549	0	0.00352	114	16MC	2.393	391	5	0.00612
5	14ME	0.247	667	10	0.00037	60	6B	1.853	507	0	0.00365	115	1MC3	3.461	547	7	0.00633
6	14MD	0.181	472	7	0.00038	61	5MB	0.968	264	3	0.00367	116	1MCX2	3.536	547	7	0.00646
7	11G	0.173	322	0	0.00054	62	5B	1.740	462	0	0.00377	117	16MC3	2.563	391	5	0.00656
8	11F	1.043	1842	0	0.00057	63	9ME	5.938	1512	25	0.00393	118	15MB	1.714	260	4	0.00659
9	11K	0.136	231	0	0.00059	64	3MB	1.068	264	3	0.00405	119	11Q	1.479	223	0	0.00663
10	11C	0.429	692	0	0.00062	65	18MD	2.997	728	12	0.00412	120	8MB	0.526	78	2	0.00674
11	11E	0.217	318	0	0.00068	66	1ME	4.971	1205	15	0.00413	121	11D	1.230	180	0	0.00683
12	11L	0.734	967	0	0.00076	67	11MB	1.352	319	5	0.00424	122	2MD	5.685	788	10	0.00721
13	13MB	0.105	130	2	0.00081	68	1ME14	5.126	1205	15	0.00425	123	2MD14	5.706	788	10	0.00724
14	11A	0.668	728	0	0.00092	69	17MC	1.286	283	4	0.00454	124	2MD3	5.749	788	10	0.00730
15	6A	0.143	133	0	0.00107	70	15MD	3.252	715	11	0.00455	125	2MDX2	5.770	788	10	0.00732
16	11H	1.024	921	0	0.00111	71	4D	1.151	252	0	0.00457	126	7D	2.025	269	0	0.00753
17	6MC	0.824	732	11	0.00113	72	1MD	3.906	853	11	0.00458	127	2G	5.511	728	0	0.00757
18	6MB	0.347	296	5	0.00117	73	15ME	4.243	923	15	0.00460	128	1MB3	2.321	306	4	0.00759
19	13MC	0.286	234	4	0.00122	74	9MD	5.088	1099	19	0.00463	129	11R	1.198	157	0	0.00763
20	6MD	1.445	1077	16	0.00134	75	4MC	2.238	482	6	0.00464	130	1MBX2	2.376	306	4	0.00776
21	11I	0.619	461	0	0.00134	76	4MB	1.125	241	3	0.00467	131	6D	0.526	67	0	0.00785
22	11M	0.807	593	0	0.00136	77	1ME3	5.636	1205	15	0.00468	132	12MC	4.502	557	8	0.00808
23	6ME	2.136	1464	22	0.00146	78	4ME	4.207	899	11	0.00468	133	8MC	2.244	270	5	0.00831
24	13MD	0.600	387	6	0.00155	79	1MEX2	5.702	1205	15	0.00473	134	10H	2.114	231	0	0.00915
25	11B	0.522	286	0	0.00183	80	15MC	2.510	520	8	0.00483	135	2MC	5.186	547	7	0.00948
26	11J	1.683	921	0	0.00183	81	1MD14	4.135	853	11	0.00485	136	2MC14	5.208	547	7	0.00952
27	4C	1.644	893	0	0.00184	82	4MD	3.222	658	8	0.00490	137	2MC3	5.309	547	7	0.00970
28	13ME	0.996	517	8	0.00193	83	17MC3	1.391	283	4	0.00492	138	2MCX2	5.331	547	7	0.00975
29	1D	0.832	429	0	0.00194	84	10I	3.784	759	0	0.00499	139	8ME	5.605	553	9	0.01014
30	10MB	0.960	452	7	0.00212	85	1MC	2.745	547	7	0.00502	140	16MB	1.323	127	2	0.01042
31	3ME	2.181	987	12	0.00221	86	9MB	1.600	312	6	0.00513	141	8MD	4.476	423	7	0.01058
32	4B	1.135	492	0	0.00231	87	12ME	6.121	1192	16	0.00513	142	10D	2.987	282	0	0.01059
33	11ME	3.046	1305	20	0.00233	88	16ME	3.768	720	9	0.00523	143	11P	1.026	92	0	0.01115
34	3MD	1.799	746	9	0.00241	89	1MB	1.638	306	4	0.00535	144	18MB	2.374	208	4	0.01141
35	1C	1.863	767	0	0.00243	90	17ME	3.303	612	8	0.00540	145	3A	1.501	129	0	0.01164
36	7E	2.203	891	0	0.00247	91	1MD3	4.610	853	11	0.00540	146	16MB3	1.509	127	2	0.01188
37	11MC	1.687	664	10	0.00254	92	16ME3	3.938	720	9	0.00547	147	12MB	3.702	303	4	0.01222
38	10MC	2.294	878	14	0.00261	93	9MC	3.754	686	13	0.00547	148	1F	2.642	215	0	0.01229
39	11MD	2.538	960	15	0.00264	94	1MDX2	4.688	853	11	0.00550	149	2B	5.670	428	0	0.01325
40	3MC	1.429	528	6	0.00271	95	1MC14	3.018	547	7	0.00552	150	2F	5.426	408	0	0.01330
41	7A	2.622	948	0	0.00277	96	5A	2.803	507	0	0.00553	151	2C	5.469	384	0	0.01424
42	17MB	0.427	153	2	0.00279	97	17MD	2.568	459	6	0.00559	152	9A	6.148	354	0	0.01737
43	5MC	1.733	616	7	0.00281	98	17ME3	3.453	612	8	0.00564	153	10F	2.321	133	0	0.01745
44	10MD	3.736	1301	21	0.00287	99	10C	2.723	481	0	0.00566	154	2MB	4.648	241	3	0.01929
45	7MC	1.518	520	8	0.00292	100	18MC	2.661	468	8	0.00569	155	2MB14	4.670	241	3	0.01938
46	7MD	2.286	780	12	0.00293	101	16MD	3.095	544	7	0.00569	156	2MB3	4.857	241	3	0.02015
47	5ME	3.630	1232	14	0.00295	102	10E	3.026	527	0	0.00574	157	2MBX2	4.878	241	3	0.02024
48	7ME	3.114	1040	16	0.00299	103	6C	1.452	252	0	0.00576	158	10A	5.891	290	0	0.02031
49	10ME	5.152	1675	28	0.00308	104	12MD	5.307	909	12	0.00584	159	2H	5.560	266	0	0.02090
50	5C	3.994	1288	0	0.00310	105	17MD3	2.703	459	6	0.00589	160	2D	5.453	198	0	0.02754
51	17MB3	0.477	153	2	0.00312	106	10B	4.269	720	0	0.00593	161	7C	2.601	89	0	0.02923
52	7MB	0.812	260	4	0.00312	107	2ME	6.127	1029	13	0.00595	162	2A	5.042	112	0	0.04502
53	1E	0.846	266	0	0.00318	108	2ME3	6.140	1029	13	0.00597	163	2E	5.512	112	0	0.04921
54	5MD	2.886	880	10	0.00328	109	2ME14	6.147	1029	13	0.00597	164	10G	3.482	38	0	0.09163
55	1B	1.163	354	0	0.00328	110	2MEX2	6.160	1029	13	0.00599						

Appendix G. Rank Ordering of Contract Impact/Cost Ratios

CO = 30%, AoE = 23%, UP = 47%

Rank	Contract	Impact	Dollars	Impact/$	Cum Impact	Cum Dollars
1	11N	0.513	1842	0.00028	0.513	1842
2	11O	0.481	1685	0.00029	0.994	3527
3	11G	0.184	322	0.00057	1.178	3849
4	11K	0.141	231	0.00061	1.320	4080
5	11E	0.197	318	0.00062	1.517	4398
6	11F	1.166	1842	0.00063	2.683	6240
7	11C	0.463	692	0.00067	3.146	6932
8	11L	0.699	967	0.00072	3.845	7899
9	11A	0.649	728	0.00089	4.494	8627
10	11H	1.083	921	0.00118	5.577	9548
11	6A	0.161	133	0.00121	5.738	9681
12	11M	0.736	593	0.00124	6.474	10274
13	11I	0.664	461	0.00144	7.138	10735
14	11J	1.672	921	0.00182	8.810	11656
15	11B	0.544	286	0.00190	9.355	11942
16	4C	1.704	893	0.00191	11.059	12835
17	1D	0.837	429	0.00195	11.896	13264
18	4B	1.178	492	0.00239	13.074	13756
19	1C	1.838	767	0.00240	14.912	14523
20	7E	2.323	891	0.00261	17.236	15414
21	7A	2.714	948	0.00286	19.949	16362
22	1E	0.781	266	0.00294	20.730	16628
23	1B	1.061	354	0.00300	21.791	16982
24	5C	3.908	1288	0.00303	25.700	18270
25	1A	1.856	549	0.00338	27.556	18819
26	6B	1.821	507	0.00359	29.377	19326
27	4A	0.825	229	0.00360	30.202	19555
28	4E	1.273	347	0.00367	31.475	19902
29	5B	1.738	462	0.00376	33.213	20364
30	10I	3.530	759	0.00465	36.743	21123
31	4D	1.197	252	0.00475	37.940	21375
32	10E	2.844	527	0.00540	40.783	21902
33	5A	2.754	507	0.00543	43.537	22409
34	6C	1.423	252	0.00565	44.961	22661
35	8A	4.586	792	0.00579	49.547	23453
36	10C	2.821	481	0.00587	52.368	23934
37	10B	4.451	720	0.00618	56.820	24654
38	11Q	1.477	223	0.00662	58.296	24877
39	11D	1.197	180	0.00665	59.493	25057
40	11R	1.182	157	0.00753	60.675	25214
41	2G	5.751	728	0.00790	66.426	25942
42	7D	2.157	269	0.00802	68.583	26211
43	6D	0.539	67	0.00804	69.122	26278
44	10H	2.024	231	0.00876	71.146	26509
45	10D	2.804	282	0.00994	73.951	26791
46	11P	0.943	92	0.01025	74.894	26883
47	3A	1.467	129	0.01137	76.361	27012
48	1F	2.556	215	0.01189	78.917	27227
49	2B	5.904	428	0.01379	84.820	27655
50	2F	5.704	408	0.01398	90.524	28063
51	2C	5.716	384	0.01489	96.241	28447
52	10F	2.222	133	0.01671	98.463	28580
53	9A	5.995	354	0.01693	104.458	28934
54	10A	5.769	290	0.01989	110.227	29224
55	2H	5.785	266	0.02175	116.012	29490
56	2D	5.696	198	0.02877	121.708	29688
57	7C	2.709	89	0.03044	124.418	29777
58	2A	5.244	112	0.04682	129.662	29889
59	2E	5.781	112	0.05162	135.443	30001
60	10G	3.395	38	0.08934	138.838	30039

CO = 50%, AoE = 17%, UP = 33%

Rank	Contract	Impact	Dollars	Impact/$	Cum Impact	Cum Dollars
1	11N	0.663	1842	0.00036	0.663	1842
2	11O	0.669	1685	0.00040	1.332	3527
3	11K	0.147	231	0.00064	1.479	3758
4	11G	0.211	322	0.00065	1.690	4080
5	11F	1.242	1842	0.00067	2.932	5922
6	11C	0.469	692	0.00068	3.401	6614
7	11E	0.277	318	0.00087	3.678	6932
8	11L	1.030	967	0.00107	4.708	7899
9	6A	0.152	133	0.00114	4.861	8032
10	11A	0.907	728	0.00125	5.768	8760
11	11H	1.278	921	0.00139	7.046	9681
12	11I	0.774	461	0.00168	7.820	10142
13	11M	1.202	593	0.00203	9.021	10735
14	11B	0.671	286	0.00234	9.692	11021
15	4C	2.180	893	0.00244	11.872	11914
16	11J	2.315	921	0.00251	14.188	12835
17	1D	1.100	429	0.00256	15.287	13264
18	7E	2.371	891	0.00266	17.658	14155
19	7A	2.584	948	0.00273	20.242	15103
20	4B	1.504	492	0.00306	21.747	15595
21	1C	2.407	767	0.00314	24.154	16362
22	5C	4.447	1288	0.00345	28.601	17650
23	6B	2.182	507	0.00430	30.783	18157
24	1E	1.188	266	0.00447	31.972	18423
25	4E	1.560	347	0.00450	33.531	18770
26	5B	2.100	462	0.00455	35.631	19232
27	4A	1.073	229	0.00468	36.704	19461
28	1A	2.575	549	0.00469	39.279	20010
29	1B	1.685	354	0.00476	40.964	20364
30	10I	3.953	759	0.00521	44.917	21123
31	4D	1.530	252	0.00607	46.448	21375
32	6D	0.436	67	0.00651	46.884	21442
33	10E	3.491	527	0.00662	50.375	21969
34	10B	4.955	720	0.00688	55.330	22689
35	6C	1.736	252	0.00689	57.066	22941
36	8A	5.466	792	0.00690	62.532	23733
37	5A	3.517	507	0.00694	66.049	24240
38	10C	3.463	481	0.00720	69.512	24721
39	10H	1.670	231	0.00723	71.182	24952
40	7D	2.046	269	0.00761	73.228	25221
41	11Q	1.991	223	0.00893	75.219	25444
42	2G	6.965	728	0.00957	82.184	26172
43	11D	1.756	180	0.00976	83.940	26352
44	11R	1.610	157	0.01025	85.550	26509
45	10D	3.507	282	0.01244	89.057	26791
46	1F	2.796	215	0.01300	91.853	27006
47	10F	1.758	133	0.01322	93.610	27139
48	3A	1.829	129	0.01418	95.439	27268
49	11P	1.477	92	0.01606	96.916	27360
50	2B	6.943	428	0.01622	103.859	27788
51	2F	6.725	408	0.01648	110.583	28196
52	2C	6.809	384	0.01773	117.392	28580
53	9A	6.942	354	0.01961	124.334	28934
54	10A	6.140	290	0.02117	130.474	29224
55	2H	6.989	266	0.02628	137.463	29490
56	2D	6.795	198	0.03432	144.258	29688
57	7C	3.305	89	0.03714	147.563	29777
58	2A	6.107	112	0.05452	153.670	29889
59	2E	6.855	112	0.06120	160.525	30001
60	10G	3.193	38	0.08403	163.718	30039

Appendix G. Rank Ordering of Contract Impact/Cost Ratios

CO = 45%, AoE = 10%, UP = 45%

Rank	Contract	Impact	Dollars	Impact/$	Cum Impact	Cum Dollars
1	11N	0.581	1842	0.00032	0.581	1842
2	11O	0.595	1685	0.00035	1.177	3527
3	11F	1.020	1842	0.00055	2.196	5369
4	11G	0.180	322	0.00056	2.376	5691
5	11K	0.136	231	0.00059	2.512	5922
6	11C	0.414	692	0.00060	2.927	6614
7	11E	0.267	318	0.00084	3.194	6932
8	11L	0.916	967	0.00095	4.110	7899
9	6A	0.130	133	0.00098	4.240	8032
10	11A	0.806	728	0.00111	5.046	8760
11	11H	1.092	921	0.00119	6.137	9681
12	11I	0.651	461	0.00141	6.788	10142
13	11M	1.076	593	0.00181	7.864	10735
14	11B	0.574	286	0.00201	8.438	11021
15	4C	1.852	893	0.00207	10.290	11914
16	11J	2.010	921	0.00218	12.300	12835
17	1D	0.961	429	0.00224	13.261	13264
18	7E	2.167	891	0.00243	15.428	14155
19	4B	1.277	492	0.00260	16.705	14647
20	7A	2.512	948	0.00265	19.217	15595
21	1C	2.161	767	0.00282	21.378	16362
22	5C	4.307	1288	0.00334	25.684	17650
23	4E	1.300	347	0.00375	26.985	17997
24	4A	0.906	229	0.00396	27.891	18226
25	6B	2.049	507	0.00404	29.939	18733
26	1E	1.082	266	0.00407	31.022	18999
27	5B	1.922	462	0.00416	32.944	19461
28	1A	2.327	549	0.00424	35.271	20010
29	1B	1.525	354	0.00431	36.797	20364
30	4D	1.295	252	0.00514	38.091	20616
31	10I	4.123	759	0.00543	42.214	21375
32	10B	4.430	720	0.00615	46.644	22095
33	10C	2.995	481	0.00623	49.639	22576
34	5A	3.209	507	0.00633	52.848	23083
35	6C	1.623	252	0.00644	54.472	23335
36	10E	3.440	527	0.00653	57.912	23862
37	8A	5.283	792	0.00667	63.195	24654
38	6D	0.468	67	0.00698	63.663	24721
39	7D	1.904	269	0.00708	65.567	24990
40	11Q	1.738	223	0.00779	67.304	25213
41	2G	5.998	728	0.00824	73.302	25941
42	11D	1.527	180	0.00848	74.829	26121
43	10H	1.982	231	0.00858	76.810	26352
44	11R	1.420	157	0.00904	78.230	26509
45	10D	3.429	282	0.01216	81.659	26791
46	1F	2.805	215	0.01305	84.465	27006
47	3A	1.699	129	0.01317	86.163	27135
48	2B	6.072	428	0.01419	92.236	27563
49	2F	5.797	408	0.01421	98.032	27971
50	11P	1.335	92	0.01451	99.367	28063
51	2C	5.891	384	0.01534	105.258	28447
52	10F	2.138	133	0.01608	107.396	28580
53	9A	6.698	354	0.01892	114.094	28934
54	10A	6.137	290	0.02116	120.231	29224
55	2H	6.049	266	0.02274	126.280	29490
56	2D	5.881	198	0.02970	132.161	29688
57	7C	2.845	89	0.03197	135.006	29777
58	2A	5.372	112	0.04797	140.379	29889
59	2E	5.914	112	0.05281	146.293	30001
60	10G	3.424	38	0.09011	149.717	30039

CO = 35%, AoE = 30%, UP = 35%

Rank	Contract	Impact	Dollars	Impact/$	Cum Impact	Cum Dollars
1	11N	0.595	1842	0.00032	0.595	1842
2	11O	0.555	1685	0.00033	1.150	3527
3	11E	0.208	318	0.00065	1.357	3845
4	11K	0.152	231	0.00066	1.509	4076
5	11G	0.215	322	0.00067	1.725	4398
6	11C	0.519	692	0.00075	2.243	5090
7	11F	1.388	1842	0.00075	3.631	6932
8	11L	0.813	967	0.00084	4.444	7899
9	11A	0.750	728	0.00103	5.194	8627
10	6A	0.183	133	0.00138	5.377	8760
11	11H	1.269	921	0.00138	6.646	9681
12	11M	0.862	593	0.00145	7.508	10274
13	11I	0.788	461	0.00171	8.296	10735
14	11J	1.977	921	0.00215	10.273	11656
15	11B	0.641	286	0.00224	10.914	11942
16	1D	0.976	429	0.00227	11.890	12371
17	4C	2.033	893	0.00228	13.922	13264
18	1C	2.085	767	0.00272	16.007	14031
19	7E	2.527	891	0.00284	18.534	14922
20	4B	1.405	492	0.00286	19.939	15414
21	7A	2.787	948	0.00294	22.726	16362
22	5C	4.049	1288	0.00314	26.775	17650
23	1E	0.887	266	0.00333	27.662	17916
24	1B	1.221	354	0.00345	28.882	18270
25	1A	2.104	549	0.00383	30.986	18819
26	6B	1.954	507	0.00385	32.941	19326
27	5B	1.916	462	0.00415	34.856	19788
28	4A	0.992	229	0.00433	35.848	20017
29	4E	1.532	347	0.00441	37.380	20364
30	10I	3.361	759	0.00443	40.741	21123
31	10E	2.894	527	0.00549	43.635	21650
32	4D	1.433	252	0.00568	45.068	21902
33	8A	4.770	792	0.00602	49.838	22694
34	5A	3.062	507	0.00604	52.900	23201
35	6C	1.536	252	0.00609	54.436	23453
36	10C	3.289	481	0.00684	57.725	23934
37	10B	4.976	720	0.00691	62.701	24654
38	10H	1.712	231	0.00741	64.413	24885
39	6D	0.507	67	0.00757	64.920	24952
40	11Q	1.730	223	0.00776	66.650	25175
41	11D	1.426	180	0.00792	68.076	25355
42	7D	2.299	269	0.00855	70.375	25624
43	11R	1.373	157	0.00874	71.747	25781
44	2G	6.719	728	0.00923	78.466	26509
45	10D	2.882	282	0.01022	81.348	26791
46	11P	1.086	92	0.01180	82.434	26883
47	1F	2.546	215	0.01184	84.980	27098
48	3A	1.597	129	0.01238	86.577	27227
49	10F	1.842	133	0.01385	88.419	27360
50	2B	6.774	428	0.01583	95.193	27788
51	2F	6.632	408	0.01625	101.825	28196
52	2C	6.634	384	0.01728	108.459	28580
53	9A	6.239	354	0.01762	114.698	28934
54	10A	5.771	290	0.01990	120.469	29224
55	2H	6.726	266	0.02528	127.195	29490
56	2D	6.610	198	0.03338	133.804	29688
57	7C	3.170	89	0.03562	136.974	29777
58	2A	5.979	112	0.05338	142.953	29889
59	2E	6.722	112	0.06001	149.675	30001
60	10G	3.164	38	0.08326	152.838	30039

Appendix G. Rank Ordering of Contract Impact/Cost Ratios

CO = 47%, AoE = 23%, UP = 30%

Rank	Contract	Impact	Dollars	Impact/$	Cum Impact	Cum Dollars
1	11N	0.668	1842	0.00036	0.668	1842
2	11O	0.656	1685	0.00039	1.323	3527
3	11K	0.152	231	0.00066	1.476	3758
4	11G	0.222	322	0.00069	1.698	4080
5	11C	0.504	692	0.00073	2.202	4772
6	11F	1.364	1842	0.00074	3.567	6614
7	11E	0.258	318	0.00081	3.824	6932
8	11L	0.995	967	0.00103	4.820	7899
9	11A	0.889	728	0.00122	5.708	8627
10	6A	0.170	133	0.00128	5.878	8760
11	11H	1.337	921	0.00145	7.215	9681
12	11I	0.820	461	0.00178	8.035	10142
13	11M	1.130	593	0.00191	9.165	10735
14	11B	0.693	286	0.00242	9.858	11021
15	11J	2.304	921	0.00250	12.163	11942
16	4C	2.240	893	0.00251	14.403	12835
17	1D	1.105	429	0.00257	15.508	13264
18	7E	2.490	891	0.00280	17.998	14155
19	7A	2.676	948	0.00282	20.674	15103
20	1C	2.382	767	0.00311	23.056	15870
21	4B	1.547	492	0.00314	24.603	16362
22	5C	4.362	1288	0.00339	28.965	17650
23	1E	1.123	266	0.00422	30.088	17916
24	6B	2.151	507	0.00424	32.239	18423
25	1B	1.584	354	0.00447	33.822	18777
26	5B	2.098	462	0.00454	35.920	19239
27	1A	2.500	549	0.00455	38.420	19788
28	4E	1.637	347	0.00472	40.057	20135
29	4A	1.101	229	0.00481	41.159	20364
30	10I	3.699	759	0.00487	44.858	21123
31	4D	1.576	252	0.00626	46.434	21375
32	10E	3.309	527	0.00628	49.743	21902
33	8A	5.295	792	0.00669	55.038	22694
34	6D	0.449	67	0.00671	55.488	22761
35	6C	1.707	252	0.00677	57.194	23013
36	10H	1.580	231	0.00684	58.774	23244
37	5A	3.469	507	0.00684	62.243	23751
38	10B	5.137	720	0.00713	67.380	24471
39	10C	3.561	481	0.00740	70.941	24952
40	7D	2.178	269	0.00810	73.119	25221
41	11Q	1.988	223	0.00891	75.107	25444
42	11D	1.722	180	0.00957	76.829	25624
43	2G	7.205	728	0.00990	84.034	26352
44	11R	1.594	157	0.01015	85.628	26509
45	10D	3.325	282	0.01179	88.953	26791
46	10F	1.659	133	0.01247	90.612	26924
47	1F	2.709	215	0.01260	93.321	27139
48	3A	1.795	129	0.01391	95.116	27268
49	11P	1.394	92	0.01516	96.510	27360
50	2B	7.176	428	0.01677	103.687	27788
51	2F	7.003	408	0.01716	110.690	28196
52	2C	7.057	384	0.01838	117.746	28580
53	9A	6.789	354	0.01918	124.535	28934
54	10A	6.018	290	0.02075	130.553	29224
55	2H	7.215	266	0.02712	137.768	29490
56	2D	7.037	198	0.03554	144.806	29688
57	7C	3.414	89	0.03836	148.219	29777
58	2A	6.309	112	0.05633	154.528	29889
59	2E	7.124	112	0.06361	161.652	30001
60	10G	3.106	38	0.08174	164.758	30039

CO = 33%, AoE = 17%, UP = 50%

Rank	Contract	Impact	Dollars	Impact/$	Cum Impact	Cum Dollars
1	11N	0.508	1842	0.00028	0.508	1842
2	11O	0.495	1685	0.00029	1.003	3527
3	11G	0.173	322	0.00054	1.175	3849
4	11F	1.043	1842	0.00057	2.219	5691
5	11K	0.136	231	0.00059	2.355	5922
6	11C	0.429	692	0.00062	2.783	6614
7	11E	0.217	318	0.00068	3.000	6932
8	11L	0.734	967	0.00076	3.734	7899
9	11A	0.668	728	0.00092	4.402	8627
10	6A	0.143	133	0.00107	4.545	8760
11	11H	1.024	921	0.00111	5.568	9681
12	11I	0.619	461	0.00134	6.187	10142
13	11M	0.807	593	0.00136	6.994	10735
14	11B	0.522	286	0.00183	7.517	11021
15	11J	1.683	921	0.00183	9.200	11942
16	4C	1.644	893	0.00184	10.844	12835
17	1D	0.832	429	0.00194	11.676	13264
18	4B	1.135	492	0.00231	12.811	13756
19	1C	1.863	767	0.00243	14.675	14523
20	7E	2.203	891	0.00247	16.878	15414
21	7A	2.622	948	0.00277	19.500	16362
22	5C	3.994	1288	0.00310	23.494	17650
23	1E	0.846	266	0.00318	24.340	17916
24	1B	1.163	354	0.00328	25.503	18270
25	4E	1.195	347	0.00344	26.698	18617
26	4A	0.796	229	0.00348	27.495	18846
27	1A	1.931	549	0.00352	29.425	19395
28	6B	1.853	507	0.00365	31.278	19902
29	5B	1.740	462	0.00377	33.018	20364
30	4D	1.151	252	0.00457	34.169	20616
31	10I	3.784	759	0.00499	37.953	21375
32	5A	2.803	507	0.00553	40.756	21882
33	10C	2.723	481	0.00566	43.479	22363
34	10E	3.026	527	0.00574	46.505	22890
35	6C	1.452	252	0.00576	47.958	23142
36	10B	4.269	720	0.00593	52.227	23862
37	8A	4.757	792	0.00601	56.984	24654
38	11Q	1.479	223	0.00663	58.464	24877
39	11D	1.230	180	0.00683	59.694	25057
40	7D	2.025	269	0.00753	61.719	25326
41	2G	5.511	728	0.00757	67.230	26054
42	11R	1.198	157	0.00763	68.428	26211
43	6D	0.526	67	0.00785	68.954	26278
44	10H	2.114	231	0.00915	71.068	26509
45	10D	2.987	282	0.01059	74.055	26791
46	11P	1.026	92	0.01115	75.081	26883
47	3A	1.501	129	0.01164	76.582	27012
48	1F	2.642	215	0.01229	79.224	27227
49	2B	5.670	428	0.01325	84.893	27655
50	2F	5.426	408	0.01330	90.319	28063
51	2C	5.469	384	0.01424	95.788	28447
52	9A	6.148	354	0.01737	101.935	28801
53	10F	2.321	133	0.01745	104.257	28934
54	10A	5.891	290	0.02031	110.147	29224
55	2H	5.560	266	0.02090	115.707	29490
56	2D	5.453	198	0.02754	121.160	29688
57	7C	2.601	89	0.02923	123.762	29777
58	2A	5.042	112	0.04502	128.804	29889
59	2E	5.512	112	0.04921	134.316	30001
60	10G	3.482	38	0.09163	137.797	30039

Appendix H. Rank Ordering of Non-Organization 11 Contract Impact/Cost Ratios

CO = 30%, AoE = 23%, UP = 47%

Rank	Contract	Impact	Dollars	Impact/$	Cum Impact	Cum Dollars
1	6A	0.161	133	0.00121	0.161	133
2	4C	1.704	893	0.00191	1.865	1026
3	1D	0.837	429	0.00195	2.702	1455
4	4B	1.178	492	0.00239	3.880	1947
5	1C	1.838	767	0.00240	5.718	2714
6	7E	2.323	891	0.00261	8.042	3605
7	7A	2.714	948	0.00286	10.755	4553
8	1E	0.781	266	0.00294	11.536	4819
9	1B	1.061	354	0.00300	12.597	5173
10	5C	3.908	1288	0.00303	16.506	6461
11	1A	1.856	549	0.00338	18.362	7010
12	6B	1.821	507	0.00359	20.183	7517
13	4A	0.825	229	0.00360	21.008	7746
14	4E	1.273	347	0.00367	22.281	8093
15	5B	1.738	462	0.00376	24.019	8555
16	10I	3.530	759	0.00465	27.549	9314
17	4D	1.197	252	0.00475	28.746	9566
18	10E	2.844	527	0.00540	31.589	10093
19	5A	2.754	507	0.00543	34.343	10600
20	6C	1.423	252	0.00565	35.766	10852
21	8A	4.586	792	0.00579	40.353	11644
22	10C	2.821	481	0.00587	43.174	12125
23	10B	4.451	720	0.00618	47.625	12845
24	2G	5.751	728	0.00790	53.377	13573
25	7D	2.157	269	0.00802	55.534	13842
26	6D	0.539	67	0.00804	56.073	13909
27	10H	2.024	231	0.00876	58.096	14140
28	10D	2.804	282	0.00994	60.901	14422
29	3A	1.467	129	0.01137	62.368	14551
30	1F	2.556	215	0.01189	64.924	14766
31	2B	5.904	428	0.01379	70.827	15194
32	2F	5.704	408	0.01398	76.531	15602
33	2C	5.716	384	0.01489	82.248	15986
34	10F	2.222	133	0.01671	84.470	16119
35	9A	5.995	354	0.01693	90.465	16473
36	10A	5.769	290	0.01989	96.233	16763
37	2H	5.785	266	0.02175	102.019	17029
38	2D	5.696	198	0.02877	107.715	17227
39	7C	2.709	89	0.03044	110.424	17316
40	2A	5.244	112	0.04682	115.669	17428
41	2E	5.781	112	0.05162	121.450	17540
42	10G	3.395	38	0.08934	124.845	17578

CO = 50%, AoE = 17%, UP = 33%

Rank	Contract	Impact	Dollars	Impact/$	Cum Impact	Cum Dollars
1	6A	0.152	133	0.00114	0.152	133
2	4C	2.180	893	0.00244	2.333	1026
3	1D	1.100	429	0.00256	3.432	1455
4	7E	2.371	891	0.00266	5.803	2346
5	7A	2.584	948	0.00273	8.387	3294
6	4B	1.504	492	0.00306	9.891	3786
7	1C	2.407	767	0.00314	12.299	4553
8	5C	4.447	1288	0.00345	16.746	5841
9	6B	2.182	507	0.00430	18.928	6348
10	1E	1.188	266	0.00447	20.117	6614
11	4E	1.560	347	0.00450	21.676	6961
12	5B	2.100	462	0.00455	23.776	7423
13	4A	1.073	229	0.00468	24.849	7652
14	1A	2.575	549	0.00469	27.424	8201
15	1B	1.685	354	0.00476	29.109	8555
16	10I	3.953	759	0.00521	33.062	9314
17	4D	1.530	252	0.00607	34.593	9566
18	6D	0.436	67	0.00651	35.029	9633
19	10E	3.491	527	0.00662	38.520	10160
20	10B	4.955	720	0.00688	43.475	10880
21	6C	1.736	252	0.00689	45.211	11132
22	8A	5.466	792	0.00690	50.677	11924
23	5A	3.517	507	0.00694	54.194	12431
24	10C	3.463	481	0.00720	57.657	12912
25	10H	1.670	231	0.00723	59.327	13143
26	7D	2.046	269	0.00761	61.373	13412
27	2G	6.965	728	0.00957	68.338	14140
28	10D	3.507	282	0.01244	71.845	14422
29	1F	2.796	215	0.01300	74.641	14637
30	10F	1.758	133	0.01322	76.399	14770
31	3A	1.829	129	0.01418	78.227	14899
32	2B	6.943	428	0.01622	85.170	15327
33	2F	6.725	408	0.01648	91.895	15735
34	2C	6.809	384	0.01773	98.703	16119
35	9A	6.942	354	0.01961	105.645	16473
36	10A	6.140	290	0.02117	111.785	16763
37	2H	6.989	266	0.02628	118.775	17029
38	2D	6.795	198	0.03432	125.569	17227
39	7C	3.305	89	0.03714	128.875	17316
40	2A	6.107	112	0.05452	134.981	17428
41	2E	6.855	112	0.06120	141.836	17540
42	10G	3.193	38	0.08403	145.029	17578

Appendix H. Rank Ordering of Non-Organization 11 Contract Impact/Cost Ratios

CO = 45%, AoE = 10%, UP = 45%

Rank	Contract	Impact	Dollars	Impact/$	Cum Impact	Cum Dollars
1	6A	0.130	133	0.00098	0.130	133
2	4C	1.852	893	0.00207	1.982	1026
3	1D	0.961	429	0.00224	2.943	1455
4	7E	2.167	891	0.00243	5.110	2346
5	4B	1.277	492	0.00260	6.387	2838
6	7A	2.512	948	0.00265	8.898	3786
7	1C	2.161	767	0.00282	11.059	4553
8	5C	4.307	1288	0.00334	15.366	5841
9	4E	1.300	347	0.00375	16.666	6188
10	4A	0.906	229	0.00396	17.572	6417
11	6B	2.049	507	0.00404	19.621	6924
12	1E	1.082	266	0.00407	20.703	7190
13	5B	1.922	462	0.00416	22.625	7652
14	1A	2.327	549	0.00424	24.953	8201
15	1B	1.525	354	0.00431	26.478	8555
16	4D	1.295	252	0.00514	27.773	8807
17	10I	4.123	759	0.00543	31.895	9566
18	10B	4.430	720	0.00615	36.326	10286
19	10C	2.995	481	0.00623	39.321	10767
20	5A	3.209	507	0.00633	42.530	11274
21	6C	1.623	252	0.00644	44.153	11526
22	10E	3.440	527	0.00653	47.594	12053
23	8A	5.283	792	0.00667	52.876	12845
24	6D	0.468	67	0.00698	53.344	12912
25	7D	1.904	269	0.00708	55.248	13181
26	2G	5.998	728	0.00824	61.246	13909
27	10H	1.982	231	0.00858	63.228	14140
28	10D	3.429	282	0.01216	66.657	14422
29	1F	2.805	215	0.01305	69.462	14637
30	3A	1.699	129	0.01317	71.161	14766
31	2B	6.072	428	0.01419	77.233	15194
32	2F	5.797	408	0.01421	83.030	15602
33	2C	5.891	384	0.01534	88.921	15986
34	10F	2.138	133	0.01608	91.059	16119
35	9A	6.698	354	0.01892	97.757	16473
36	10A	6.137	290	0.02116	103.895	16763
37	2H	6.049	266	0.02274	109.944	17029
38	2D	5.881	198	0.02970	115.824	17227
39	7C	2.845	89	0.03197	118.669	17316
40	2A	5.372	112	0.04797	124.042	17428
41	2E	5.914	112	0.05281	129.956	17540
42	10G	3.424	38	0.09011	133.380	17578

CO = 35%, AoE = 30%, UP = 35%

Rank	Contract	Impact	Dollars	Impact/$	Cum Impact	Cum Dollars
1	6A	0.183	133	0.00138	0.183	133
2	1D	0.976	429	0.00227	1.159	562
3	4C	2.033	893	0.00228	3.192	1455
4	1C	2.085	767	0.00272	5.276	2222
5	7E	2.527	891	0.00284	7.803	3113
6	4B	1.405	492	0.00286	9.208	3605
7	7A	2.787	948	0.00294	11.995	4553
8	5C	4.049	1288	0.00314	16.044	5841
9	1E	0.887	266	0.00333	16.931	6107
10	1B	1.221	354	0.00345	18.152	6461
11	1A	2.104	549	0.00383	20.255	7010
12	6B	1.954	507	0.00385	22.210	7517
13	5B	1.916	462	0.00415	24.125	7979
14	4A	0.992	229	0.00433	25.117	8208
15	4E	1.532	347	0.00441	26.649	8555
16	10I	3.361	759	0.00443	30.010	9314
17	10E	2.894	527	0.00549	32.904	9841
18	4D	1.433	252	0.00568	34.337	10093
19	8A	4.770	792	0.00602	39.107	10885
20	5A	3.062	507	0.00604	42.169	11392
21	6C	1.536	252	0.00609	43.705	11644
22	10C	3.289	481	0.00684	46.994	12125
23	10B	4.976	720	0.00691	51.970	12845
24	10H	1.712	231	0.00741	53.682	13076
25	6D	0.507	67	0.00757	54.189	13143
26	7D	2.299	269	0.00855	56.488	13412
27	2G	6.719	728	0.00923	63.207	14140
28	10D	2.882	282	0.01022	66.089	14422
29	1F	2.546	215	0.01184	68.635	14637
30	3A	1.597	129	0.01238	70.232	14766
31	10F	1.842	133	0.01385	72.074	14899
32	2B	6.774	428	0.01583	78.848	15327
33	2F	6.632	408	0.01625	85.480	15735
34	2C	6.634	384	0.01728	92.114	16119
35	9A	6.239	354	0.01762	98.353	16473
36	10A	5.771	290	0.01990	104.124	16763
37	2H	6.726	266	0.02528	110.850	17029
38	2D	6.610	198	0.03338	117.460	17227
39	7C	3.170	89	0.03562	120.629	17316
40	2A	5.979	112	0.05338	126.608	17428
41	2E	6.722	112	0.06001	133.330	17540
42	10G	3.164	38	0.08326	136.494	17578

Appendix H. Rank Ordering of Non-Organization 11 Contract Impact/Cost Ratios

CO = 47%, AoE = 23%, UP = 30%

Rank	Contract	Impact	Dollars	Impact/$	Cum Impact	Cum Dollars
1	6A	0.170	133	0.00128	0.170	133
2	4C	2.240	893	0.00251	2.410	1026
3	1D	1.105	429	0.00257	3.515	1455
4	7E	2.490	891	0.00280	6.006	2346
5	7A	2.676	948	0.00282	8.682	3294
6	1C	2.382	767	0.00311	11.064	4061
7	4B	1.547	492	0.00314	12.611	4553
8	5C	4.362	1288	0.00339	16.972	5841
9	1E	1.123	266	0.00422	18.095	6107
10	6B	2.151	507	0.00424	20.246	6614
11	1B	1.584	354	0.00447	21.830	6968
12	5B	2.098	462	0.00454	23.927	7430
13	1A	2.500	549	0.00455	26.428	7979
14	4E	1.637	347	0.00472	28.065	8326
15	4A	1.101	229	0.00481	29.166	8555
16	10I	3.699	759	0.00487	32.865	9314
17	4D	1.576	252	0.00626	34.442	9566
18	10E	3.309	527	0.00628	37.750	10093
19	8A	5.295	792	0.00669	43.046	10885
20	6D	0.449	67	0.00671	43.495	10952
21	6C	1.707	252	0.00677	45.202	11204
22	10H	1.580	231	0.00684	46.782	11435
23	5A	3.469	507	0.00684	50.250	11942
24	10B	5.137	720	0.00713	55.387	12662
25	10C	3.561	481	0.00740	58.948	13143
26	7D	2.178	269	0.00810	61.126	13412
27	2G	7.205	728	0.00990	68.331	14140
28	10D	3.325	282	0.01179	71.656	14422
29	10F	1.659	133	0.01247	73.315	14555
30	1F	2.709	215	0.01260	76.024	14770
31	3A	1.795	129	0.01391	77.819	14899
32	2B	7.176	428	0.01677	84.995	15327
33	2F	7.003	408	0.01716	91.999	15735
34	2C	7.057	384	0.01838	99.055	16119
35	9A	6.789	354	0.01918	105.844	16473
36	10A	6.018	290	0.02075	111.862	16763
37	2H	7.215	266	0.02712	119.077	17029
38	2D	7.037	198	0.03554	126.114	17227
39	7C	3.414	89	0.03836	129.528	17316
40	2A	6.309	112	0.05633	135.837	17428
41	2E	7.124	112	0.06361	142.961	17540
42	10G	3.106	38	0.08174	146.067	17578

CO = 33%, AoE = 17%, UP = 50%

Rank	Contract	Impact	Dollars	Impact/$	Cum Impact	Cum Dollars
1	6A	0.143	133	0.00107	0.143	133
2	4C	1.644	893	0.00184	1.787	1026
3	1D	0.832	429	0.00194	2.619	1455
4	4B	1.135	492	0.00231	3.755	1947
5	1C	1.863	767	0.00243	5.618	2714
6	7E	2.203	891	0.00247	7.821	3605
7	7A	2.622	948	0.00277	10.443	4553
8	5C	3.994	1288	0.00310	14.438	5841
9	1E	0.846	266	0.00318	15.284	6107
10	1B	1.163	354	0.00328	16.446	6461
11	4E	1.195	347	0.00344	17.642	6808
12	4A	0.796	229	0.00348	18.438	7037
13	1A	1.931	549	0.00352	20.369	7586
14	6B	1.853	507	0.00365	22.221	8093
15	5B	1.740	462	0.00377	23.962	8555
16	4D	1.151	252	0.00457	25.112	8807
17	10I	3.784	759	0.00499	28.896	9566
18	5A	2.803	507	0.00553	31.699	10073
19	10C	2.723	481	0.00566	34.423	10554
20	10E	3.026	527	0.00574	37.449	11081
21	6C	1.452	252	0.00576	38.901	11333
22	10B	4.269	720	0.00593	43.170	12053
23	8A	4.757	792	0.00601	47.928	12845
24	7D	2.025	269	0.00753	49.953	13114
25	2G	5.511	728	0.00757	55.464	13842
26	6D	0.526	67	0.00785	55.989	13909
27	10H	2.114	231	0.00915	58.103	14140
28	10D	2.987	282	0.01059	61.090	14422
29	3A	1.501	129	0.01164	62.591	14551
30	1F	2.642	215	0.01229	65.233	14766
31	2B	5.670	428	0.01325	70.903	15194
32	2F	5.426	408	0.01330	76.328	15602
33	2C	5.469	384	0.01424	81.797	15986
34	9A	6.148	354	0.01737	87.945	16340
35	10F	2.321	133	0.01745	90.266	16473
36	10A	5.891	290	0.02031	96.157	16763
37	2H	5.560	266	0.02090	101.717	17029
38	2D	5.453	198	0.02754	107.170	17227
39	7C	2.601	89	0.02923	109.771	17316
40	2A	5.042	112	0.04502	114.813	17428
41	2E	5.512	112	0.04921	120.325	17540
42	10G	3.482	38	0.09163	123.807	17578

Appendix I. Less Than $3 Million Cut From Organization 11

	Changing Current Operations					Changing Areas of Emphasis					Changing Unit Performance					
CO	.20	.30	**.40**	.50	.60	.50	.45	**.40**	.35	.30	.53	.47	**.40**	.33	.27	
AoE	.27	.23	**.20**	.17	.13	.00	.10	**.20**	.30	.40	.27	.23	**.20**	.17	.13	
UP	.53	.47	**.40**	.33	.27	.50	.45	**.40**	.35	.30	.20	.30	.40	.50	.60	Total
4MA	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	15
5MA	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	15
6ME	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	15
8MA	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	15
9MA	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	15
12MA	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	15
14ME	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	15
15MA	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	15
4C	Y	Y	Y	Y		Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	14
6A	Y	Y	Y	Y	Y	Y	Y	Y	Y		Y	Y	Y	Y	Y	14
11G	Y	Y	Y	Y	Y	Y	Y	Y	Y		Y	Y	Y	Y	Y	14
1D	Y	Y	Y	Y	Y			Y	Y	Y		Y	Y	Y	Y	12
11C		Y	Y	Y	Y	Y	Y	Y	Y		Y	Y	Y		Y	12
10MB		Y	Y	Y	Y	Y	Y	Y	Y	Y		Y	Y	Y		12
11O	Y		Y	Y	Y			Y		Y	Y	Y	Y	Y	Y	11
18MA	Y	Y	Y			Y	Y	Y	Y	Y			Y	Y	Y	11
11MA			Y	Y	Y	Y	Y	Y			Y	Y	Y	Y		10
1MA14	Y	Y		Y	Y				Y	Y	Y	Y			Y	9
2MA14	Y	Y		Y	Y				Y	Y	Y	Y			Y	9
3MA	Y	Y		Y	Y				Y	Y	Y	Y			Y	9
13ME		Y	Y	Y	Y			Y	Y		Y	Y	Y			9
16MA	Y	Y		Y	Y				Y	Y	Y	Y			Y	9
11K			Y	Y	Y			Y			Y	Y	Y		Y	8
7MA	Y	Y				Y	Y		Y	Y				Y	Y	8
17MA	Y	Y		Y	Y				Y		Y	Y			Y	8
7MB			Y	Y	Y			Y			Y	Y	Y			7
1MAX2			Y			Y	Y	Y					Y	Y		6
2MAX2			Y			Y	Y	Y					Y	Y		6
3ME			Y			Y	Y	Y					Y	Y		6
16MA3			Y			Y	Y	Y					Y	Y		6
17MA3			Y			Y	Y	Y					Y	Y		6
11ME	Y	Y							Y	Y					Y	5
11N		Y				Y	Y		Y							4
18ME				Y	Y						Y	Y				4
7E					Y	Y	Y									3
11L	Y									Y				Y		3
13MD						Y	Y			Y						3
10MA	Y														Y	2
13MC	Y													Y		2
1B	Y															1
1C															Y	1
1E	Y															1
4B														Y		1
11E										Y						1
10MC											Y					1
13MB															Y	1
17MB										Y						1
Totals	26	24	25	25	25	24	24	25	24	23	24	25	25	25	26	
Impact	9.23	10.84	11.92	12.53	12.72	11.77	11.90	11.92	11.73	11.24	12.25	12.33	11.92	10.97	9.75	
Dollars	8719	8716	8732	8730	8728	8730	8730	8732	8716	8720	8727	8730	8732	8725	8718	
Personnel	56	67	63	67	67	57	57	63	67	67	74	67	63	55	54	

Appendix J. Less Than $2 Million Cut From Organization 11

	Changing Current Operations					Changing Areas of Emphasis					Changing Unit Performance					
CO	.20	.30	**.40**	.50	.60	.50	.45	.40	.35	.30	.53	.47	**.40**	.33	.27	
AoE	.27	.23	**.20**	.17	.13	.00	.10	**.20**	.30	.40	.27	.23	**.20**	.17	.13	
UP	.53	.47	**.40**	.33	.27	.50	.45	.40	.35	.30	.20	.30	**.40**	.50	.60	Total
6A	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	15
4MA	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	15
5MA	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	15
6ME	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	15
8MA	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	15
9MA	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	15
12MA	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	15
14ME	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	15
15MA	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	15
4C	1	1	1	1	0	1	1	1	1	1	1	1	1	1	1	14
1D	1	1	1	1	1	0	1	1	1	1	0	1	1	1	1	13
10MB	1	1	1	1	1	1	1	1	1	1	0	1	1	1	0	13
13ME	0	1	1	1	1	0	1	1	1	1	1	1	1	1	0	12
11K	1	1	1	1	0	1	0	1	1	1	0	1	1	1	0	11
11O	1	1	1	1	0	1	0	1	1	1	0	1	1	1	0	11
7MA	1	1	1	0	0	1	1	1	1	1	0	0	1	1	1	11
1MAX2	1	1	1	0	0	1	1	1	1	0	0	0	1	1	1	10
2MAX2	1	1	1	0	0	1	1	1	1	0	0	0	1	1	1	10
3ME	1	1	1	0	0	1	1	1	1	0	0	0	1	1	1	10
11MA	0	0	1	1	1	1	1	1	0	0	1	1	1	1	0	10
16MA3	1	1	1	0	0	1	1	1	1	0	0	0	1	1	1	10
17MA3	1	1	1	0	0	1	1	1	1	0	0	0	1	1	1	10
18MA	1	1	1	0	0	1	1	1	1	0	0	0	1	1	1	10
1C	0	0	1	0	0	0	0	1	0	0	0	0	1	1	1	5
4B	0	0	1	0	0	0	1	1	0	0	0	0	1	1	0	5
7E	0	0	0	1	1	1	1	0	0	0	0	1	0	0	0	5
1MA14	0	0	0	1	1	0	0	0	0	1	1	1	0	0	0	5
2MA14	0	0	0	1	1	0	0	0	0	1	1	1	0	0	0	5
3MA	0	0	0	1	1	0	0	0	0	1	1	1	0	0	0	5
11ME	1	1	0	0	0	0	0	0	1	1	0	0	0	0	1	5
16MA	0	0	0	1	1	0	0	0	0	1	1	1	0	0	0	5
18ME	0	0	0	1	1	0	0	0	0	1	1	1	0	0	0	5
11N	0	0	0	0	1	0	1	0	0	0	1	0	0	0	1	4
7MB	0	0	0	1	1	0	0	0	0	0	1	1	0	0	0	4
17MB	0	0	0	1	1	0	0	0	0	0	1	1	0	0	0	4
7A	0	0	0	0	1	1	0	0	0	0	1	0	0	0	0	3
1B	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
10MA	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1
10MC	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	1
13MB	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
13MC	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1
13MD	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	1
17MA	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	1
Totals	24	23	25	24	23	24	24	25	23	23	22	24	25	25	23	
Impact	10.69	12.47	13.91	14.58	14.72	13.79	13.91	13.91	13.53	12.96	14.31	14.44	13.91	12.77	11.23	
Dollars	8730	8763	8717	8760	8741	8738	8767	8717	8763	8761	8740	8760	8717	8717	8721	
Personnel	73	79	59	69	69	57	59	59	79	83	76	69	59	59	68	

Appendix K. No Contracts Cut From Organization 11

	Changing Current Operations					Changing Areas of Emphasis					Changing Unit Performance					
CO	.20	.30	**.40**	.50	.60	.50	.45	**.40**	.35	.30	.53	.47	**.40**	.33	.27	
AoE	.27	.23	**.20**	.17	.13	.00	.10	**.20**	.30	.40	.27	.23	**.20**	.17	.13	
UP	.53	.47	**.40**	.33	.27	.50	.45	**.40**	.35	.30	.20	.30	**.40**	.50	.60	Total
14ME	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	15
9MA	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	15
8MA	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	15
6ME	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	15
4MA	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	15
4C	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	15
1D	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	15
15MA	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	15
12MA	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	15
3ME	1	1	1	1	1	1	1	1	1	1	0	1	1	1	1	14
16MA3	1	1	1	1	1	1	1	1	1	1	0	1	1	1	1	14
2MAX2	1	1	1	1	1	1	1	1	1	1	0	1	1	1	1	14
1MAX2	1	1	1	1	1	1	1	1	1	1	0	1	1	1	1	14
5MA	1	0	1	1	1	1	1	1	1	1	1	1	1	1	1	14
6A	1	1	1	1	1	1	1	1	1	1	1	1	1	0	0	13
10MB	1	1	1	1	1	1	1	1	1	1	0	0	1	1	1	13
7E	0	0	1	1	1	1	1	1	0	0	1	1	1	1	1	11
13ME	1	1	1	1	1	0	0	1	1	1	1	1	1	0	0	11
17MA3	1	1	1	0	0	1	1	1	0	0	0	1	1	1	1	10
7MA	1	1	1	0	0	0	0	1	1	1	0	1	1	1	1	10
18ME	0	0	1	1	1	0	0	1	1	1	1	1	1	0	0	9
11ME	1	1	1	0	0	0	0	1	1	1	0	0	1	1	1	9
1C	1	1	0	0	0	1	1	0	1	1	0	0	0	1	1	8
7A	0	0	0	1	1	1	1	0	0	0	1	1	0	0	0	6
4B	1	1	0	0	0	1	1	0	0	0	0	0	0	1	1	6
11MA	0	0	0	1	1	1	1	0	0	0	1	1	0	0	0	6
18MA	1	1	0	0	0	1	1	0	0	0	0	0	0	1	1	6
17MB3	0	0	0	1	1	0	0	0	1	1	0	0	0	0	0	4
13MD	0	0	0	0	0	1	1	0	0	0	0	0	0	1	1	4
7MB	0	0	0	1	1	1	1	0	0	0	0	0	0	0	0	4
10MC	0	0	0	0	0	0	0	0	0	0	1	1	0	0	0	2
7MD	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	1
5MC	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	1
1E	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
1B	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
17MB	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	1
1MA14	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	1
2MA14	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	1
16MA	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	1
3MA	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	1
Totals	25	23	22	23	23	25	25	22	22	22	23	23	22	23	23	
Impact	14.26	16.56	18.51	19.12	19.44	18.17	18.43	18.51	17.90	17.09	19.14	19.06	18.51	16.85	15.03	
Dollars	8726	8722	8723	8779	8779	8770	8770	8723	8752	8752	8738	8792	8723	8734	8734	
Personnel	79	86	95	81	81	61	61	95	97	97	84	82	95	77	77	

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Vita

Captain Thomas G. Boushell was born 11 April 1971 in Baltimore, Maryland. He was the first 160 pound Maryland State Wrestling Champion and was an All-America in lacrosse while attending Perry Hall High School. After graduating from Perry Hall High School in 1989, he entered the United States Air Force Academy on 29 June 1989. He was a member of 3rd Squadron and a four-year Varsity Lacrosse letterman. On 2 June 1993, he graduated from USAFA with a Bachelor of Science degree in Astronautical Engineering. His first assignment was at Vandenberg AFB as a Space Vehicle, Test and Integration Engineer and Mission Test Manager. While at Vandenberg AFB, he worked with one-of-a-kind Space Test Experiments Platform-series space vehicles and Taurus and Pegasus launch vehicles. In January of 1994, he met his beautiful wife, Jennifer, on the 101 Freeway. They were married on 13 April 1996 in Ventura, California. On 1 August 1996, he moved to Wright-Patterson AFB, Ohio to attend the Air Force Institute of Technology. On 24 March 1998, he graduated from AFIT with a Master's Degree in Operations Research.

Captain Boushell and his wife have two dogs, Camden and Wrigley, and are expecting their first child in August of 1998.

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13. ABSTRACT *(Maximum 200 words)*

The National Air Intelligence Center (NAIC), like many Department of Defense (DoD) and civilian organizations, has been forced to undergo budget and manpower reductions. This year's resource allocation decision requires NAIC to identify both contracts and personnel to be cut. In order to reduce the amount of time and subjectivity involved in this important decision, a resource allocation model was developed to compare different alternatives. This model uses decision analysis with value-focused thinking to quantify the resultant impact of the chosen cuts. The impact was quantified based upon the NAIC Commander's values and preferences, which were used to build a value hierarchy. Each of the 60 contracts, as well as the 5, 10, 15 and 20% manpower cuts for the 18 organizations within NAIC, were evaluated against 49 attributes, which represented the Commander's values. Using multi-attribute utility theory, the subjective scores were multiplied by the commander's preference to arrive at an overall utility score. In addition to identifying the absolute best alternative, a rank ordering based upon the impact/cost ratio was supplied to the NAIC Commander. By including sensitivity analysis on the commander's preferences, NAIC could better understand their resource allocation problem and make a more-informed decision.

14. SUBJECT TERMS	15. NUMBER OF PAGES
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